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## THE TELEPHONE MONOPOLY.

PEOPLE who have become aware of what has been achieved in America and in various Continental towns have long wonderingly enquired the reason of the slow progress made in this country in the general introduction of the telephone to common usage. The reply has invariably been, on the part of interested parties, that the regulations imposed by the Government were far too stringent to admit of much extension or enterprise on the part of the companies, or of a considerable lessening in the high charge made for connection with the exchanges. This has, no doubt, been absolutely true, and we have taken our part in urging upon the authorities the pressing necessity for an abatement of their harsh requirements. There was a consensus of opinion throughout the country that the terms imposed by the Post Office Department, which claimed authority by virtue of the Telegraph Act, were calculated to stifle one of the most useful developments of modern scientific discovery; this culminated last year in a general demand for the abolition of those restrictions, and the late Postmaster-General, the lamented Mr. Fawcett, was at length brought to see the justice of the cry, with the result that much more favourable terms were granted. But the object of the present article is to contend that those restrictions did not comprise the only cause of the backward state of the telephone in England. Other influences were at work, the most potent, undoubtedly, being the existence of a practical monopoly, the holders of the Edison-Gower-Bell patents having been successful in keeping all competitors out of the field. This, then, has been the main cause why English towns are far worse served in the matter of telephonic communication than towns in some other countries. The comparisons we have from time to time instituted amply prove that a much greater advance has been made abroad than we have yet witnessed, and information which now comes from Sweden still further demonstrates this. Greatly to the credit of this plucky nation, which has many natural difficulties to contend with, and which we are too apt to consider as being out of Europe and almost out of reach of European "civilising" influences, it is stated that, relatively to its population and commercial importance, it has adopted the telephone more extensively than any other European country. Even the smallest towns have their installations, and, their inhabitants having formed mutual societies, the benefits of the telephone have been obtained at little more than cost price. Here is to be perceived the beneficial influence which competition exercises in stimulating an industry. Until October, 1883, the Bell Company had a monopoly of the service, the annual subscriptions varying from about £16 to about £9, according to the extent of the lines. At this time, however, the General Telephone Company of Stockholm came into the field, commencing business with 332 lines, the annual subscription being fixed at £5 15s. At the end of that year, two months only having elapsed since the opening of the first exchange, the company had 785 subscribers; on February 15th, 1885, the total number was 2,536. An eloquent fact this, considering that Sweden, in many parts, is most sparsely peopled, Stockholm and its suburbs only possessing a population of 200,000. The company is now constructing a central station for 7,200 lines. The Bell Company has reduced its subscription to about seven guineas, and has retained 1,450 of its subscribers. As a contemporary points out, and as the figures we have given show, in the neighbourhood of Stockholm one person in every fifty has telephonic connection; taking the accepted average of five persons to a family, one household in ten is found to be in the enjoyment of that which in England, and particularly in London, is a luxury of price. And such will it remain, we believe—notwithstanding what has been done, and, still more, what has been promised, since the concessions made last year by the Postmaster-General—so long as the absence of competition remains. That this monopoly will long continue it requires a very sanguine believer in the infallibility of the patents which now hold the field against all comers to assert; but, on the other hand, so successful have these patents been in their many fights that a strong degree of assurance is necessary on the part of any who would challenge them. We are promised something exciting in the shape of a contest in the course of the next week or so, but time only can show us whether the promise will be borne out.

It may be of interest, whilst alluding to telephone matters, to draw attention to what is taking place on the other side of the English Channel. In the month of July last, we learn, the public who take an interest in the fate of telephony in France were anxiously inquiring under what conditions would be renewed the concession of the General Telephone Company, which some persons boldly considered as a sort of monopoly graciously granted on the sly, whilst others more sceptical expected to see the Government do for this new art what it had done some weeks previously for the manufacture of matches. As for the solution of purchase by the State, no one dreamt of it, according to our excellent contemporary, *La Lumière Electrique*, except some shareholders who preserve in their portfolios Mexican scrip or shares in the galleons of Vigo. Matters stood thus, when suddenly there emanated from the Minister of Posts and Telegraphs the project of a law which astonished everybody. M. Cochery asked from the Chamber the right of renewing the concession of the company (though, be it understood without monopoly), and prayed at the same time the Assembly to prohibit him from granting to any one concessions for more than five years. This

project, like all projects of law, was referred to a Parliamentary Commission.

A deputy from Paris, known for his courageous support of private industry, fearing, possibly, that this compulsory delay of five years might be a serious obstacle to the formation of new companies, whilst the possibility of renewal might become in the hands of the minister the means of endowing the existing company with a hidden monopoly, deposited a counter-project, where he suggested its being offered to the best bidder, conformably to the laws on this subject, giving preference to those applicants, who, whilst paying their dues to the State, should offer to the public the most favourable terms of subscription. M. Cochery, called upon to explain himself, declared that "adjudication" was a kind of monopoly to which he was opposed, and that he would immediately grant rival concessions to all Frenchmen who gave serious guarantees. In view of such liberality the commission skilfully laid aside its share of responsibility in the ministerial project, declaring that from the moment that M. Cochery did not ask money from the country, he might, in his own defence, dispense with authorisation, as he had done once before.

The monthly bulletin of the Ministry of Posts and Telegraphs, of August 4th, 1884, registered the new ministerial decision, and the conditions which all persons desirous of new concessions must fulfil, as well as the base upon which the minister might at any moment, if he thought fit, effect the redemption of the concession without being obliged to give his reasons. It is certain, our contemporary thinks, that, unless he had in his pocket a good verbal promise from the minister, a capitalist, and still more a leading industrialist, would look twice before taking advantage of the liberal intentions of the ministerial decree.

A new project of law has just issued from the cabinet of the Minister of Posts and Telegraphs. The General Telephone Company absorbs all the space in the sewers let to it by the City, by the too bulky cables which it manufactures. The Municipal Council, proprietor of the sewers of Paris, has lately become aware that to authorise the company to keep such a plant in the sewers would amount to granting it one of those *de facto* monopolies so repugnant to M. Cochery, and that the consequence of renewing the lease granted four years ago to the company would deprive the Parisians of all chance of seeing telephony developed, and of all means of reducing the price of subscription by free competition. The Council has therefore felt it necessary to postpone its decision to May 1st. The project of law of which we have just spoken, if the Chamber votes, will invest M. Cochery with the right to requisition the roofs of all the houses in France for planting supports for telegraphic, telephonic, *and other* wires, and incidentally all the small sewers, including those of Paris. What will the deputies think of a measure which will remind France of the worst days of the terrible year? What will the Council of the City of Paris say, well acquainted as they are with all that is beneath the cards? This is what a near future will teach us. The words "*or others*" which occur repeatedly in the project, and the word "electricity" here and there, betray sufficiently the after-thought of M. Cochery to lay hands upon all affairs foreign hitherto to his Ministry, and where electricity comes into play.

If the Ministry of posts and telegraphs is to become the Ministry of electricity, some recognised electrician should be placed at its head. It would be better, as is done by other governments, to let electricity grow in freedom without wrapping it in ministerial swaddling clothes.

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**Overhead Wires.**—The Select Committee of the Commons on Telephone and Telegraph Wires met last Friday to choose their chairman and consider course of proceedings. Mr. George Russell was appointed to preside, and the committee arranged to meet on the 19th inst. at twelve o'clock to examine witnesses.

## INCANDESCENT LAMP ECONOMY.*

By ASSISTANT ENGINEER W. D. WEAVER, U. S. N.

THE cost of a given light from an incandescent lamp depends upon three quantities: the cost of the lamp, its life, and the cost of the energy to produce the light, the latter value being the entire cost of the energy actually delivered at the lamp, depreciation of plant and interest on capital being taken into consideration. The relation between these quantities may be formulated as follows:—

Let $a$ = the entire cost of one horse-power per hour *at the lamp.*
$b$ = cost of lamp.
$l$ = life of lamp.
$x$ = candle power.

Then $\frac{b}{l\,x}$ is the hourly *lamp* cost of one candle power.

$\frac{C\,E}{745} \times a \times \frac{1}{x}$ is the hourly *energy* cost of the same,

and $\frac{b}{l\,x} + \frac{a\,C\,E}{745\,x}$ is the *entire* hourly cost of the unit of light.

If now the relation between the electrical energy transformed in a lamp and the resulting candle-power were known, the economic conditions in respect to the life and cost of lamp and cost of horse-power could be determined by means of the above formula.

There is, however, a great diversity of opinion in regard to the law connecting these two variables. Dr. Higgs states that the candle-power varies as the fourth power of the current, or as the square of the energy; Dr. Hagen (Dresden) gives the powers as five and three, respectively, while Mr. Preece, in a paper read before the British Association at Montreal, gave the law that the candle-power varies as the sixth power of the current.

The plotted curve has evidently the form of curves represented by the equation $y = k\,x^n$, and its regularity suggests that the law is not so variable as to give reason for the diversity of values hitherto given, a conclusion justified by the result of the following investigation:

### I.

In the calculations the data used were those of the careful experiments made at the Crystal Palace Electrical Exhibition, contained in an able report on the exhibition made to the Navy Department by Mr. F. J. Sprague, late U. S. N.

The values of $n$ in the formula $y = k\,x^n$ were calculated for both energy and current by means of the following equations, in which P is the candle-power, C the current, and E the electromotive force between the lamp terminals:

$$n' = \frac{\log. P_2 - \log. P_1}{\log. C_2 + \log. E_2 - \log. C_1 - \log. E_1}$$

$$n'' = \frac{\log. P_2 - \log. P_1}{\log. C_2 - \log. C_1}$$

The data used were those from experiments on 18 lamps—6 Edison, 6 Swan, and 6 Maxim; the value of $n$ was calculated for each successive experiment between about 5 candle-power and the highest power noted that gave satisfactory results, and also for the extreme values of the candle-power for each lamp.

The results are as given in the following table:—

| | Number of determinations. | $n'$ $(P = K\,C\,E^{n'})$ | $n''$ $(P = K\,C^{n''})$ |
|---|---|---|---|
| Mean for successive values of candle-power ... | 51 | 2·72 | 4·64 |
| Mean for extreme values of candle-power ... | 18 | 2·71 | 4·70 |

* *Van Nostrand's Engineering Magazine.*

Adopting as the exponent of the energy the value 2·70, the probable error with the above data is between +·07 and −·03. The variation of the value of the exponent of the current is much greater, however, and, adopting the value 4·70, the probable error is ± ·30.

It would appear that $n$ has a slightly greater value for the large filament or Maxim lamp than for the lamps with finer filaments; thus, with the former the mean values of $n'$ and $n''$ are 2·75 and 4·97 respectively, and the variation small; this difference may be owing, however, to the more satisfactory data of the Maxim lamp, due to its larger range of candle-power.

Although the above values of $n$ are probably correct within the limits given, other determinations should be made with smaller increments of candle-power than in the Experiments at the Crystal Palace, and the variation of the exponent $n$, if any, determined for different sized filaments.

The following table will show the agreement of the calculated with the observed candle-power. The figures at the head of the columns are from the report on the Crystal Palace Exhibition, and were taken by the committee from curves plotted with observed data. The other values were calculated from the equation $C E = K P^{\frac{1}{2\cdot7}}$ in which $k$ was determined for the normal candle-power.

From the data of experiments made at the Munich Exhibition on the Gatehouse lamp, the following table was calculated, using the formula $C E = K P^{\frac{1}{2\cdot7}}$:

| Lamp. | Normal candle power. | $k$ | Candle power. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 10 | 15 | 20 | 30 | 60 | 90 |
| Swan... | 20 | 21·36 | 5·52 | 10·40 | 15·30 | 20 | 30·18 | 61·51 | 97·60 |
| Maxim | 20 | 26·98 | 6·18 | 10·67 | 15·17 | 20 | 29·95 | 58·30 | 94·63 |
| Edison | 16 | 30·26 | 5·92 | 10·42 | 15 | 19·7 | 30·24 | 62·37 | 102·6 |
| Observed C.P.... | | | 5·89 | 8·40 | 11·12 | 15·3 | 21·93 | 30·76 | 41·52 |
| Calculated C.P. | | | 6·87 | 9·01 | 11·67 | 15·3 | 20·3 | 27·3 | 38·3 |
| Differences ..... | | | ·98 | ·61 | ·55 | 0 | −19·3 | −3·46 | −3·12 |

As might have been expected from the difference of construction of the lamp, the agreement is not very close, and the differences show that the equation to the curve of this lamp is of a less degree, and by calculation from the data given was found to be $C E = K P^{\frac{1}{3}}$, and the constant, $k$, 25·58.

## II.

Knowing now the relation between the candle-power and energy, we will return to our first formula,

$$\frac{b}{l\,x} + \frac{a\,C\,E}{745\,x} \qquad (1)$$

Expressing the law just deduced in the same notation, and substituting for C E in (1), we have finally for the whole cost of the unit light

$$y = \frac{b}{l\,x} + \frac{a\;k\;x^{\frac{1}{2\cdot7}}}{745\;x} \qquad (2)$$

With this equation, some interesting problems in incandescent lighting may be solved, and from it the following tables were deduced, showing the economic relation between the life of a lamp, its cost, and the cost of the energy furnished it. Table I. was constructed by assuming the life of a normal 20 candle-power lamp to be 1,000 hours, and that the lamp *when working at its normal capacity* would produce the normal light at the rate of 3 watts per candle-power, the cost of the lamp being taken at $1.00, and the cost of an hourly horse-power at 1 cent.; from these data $y$ was calculated and the life of the same lamp at other candle-powers, and of other lamps of different efficiencies and at different candle-powers was found, the cost of the unit light being the same in each case and as deduced from the above data. The watts at the head of the columns represent the efficiency of the lamp, and are the number of watts required to produce the unit light when the lamp is being used at its normal power—20 candle-power in each case; the figures, 1, 2, 3 to the right of each candle-power are the respective costs of an hourly horse-power, and enable a comparison to be made between the efficiencies at these different values, the cost of the unit light and of the lamp remaining the same. The other quantities are the lives that would have to be obtained in order that the cost of the unit light may remain the same as given for each table and therefore represent the relative efficiencies of different lamps at different candle-powers and at the given constant cost of the unit of light. Table II. was calculated in the same manner, but assuming the cost, $y$, of the unit light to be that resulting when the energy cost 2 cents per hourly horse-power, and in Table III. the latter value is taken at 3 cents.

For any other cost $b'$ of a lamp, the quantities in each table should be multiplied by the ratio $\frac{b'}{100}$.

If a relation could be established between different candle-powers of a lamp and the resulting lives, by

TABLE I.

$a = 1$.

Total cost of unit light per hour,

$$y = \frac{100}{20 \times 1000} + \frac{1 \times 60}{745 \times 20} = \cdot00902.$$

| Candle-power. | Cost of hourly H.P. | WATTS. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 2·5 | 3 | 3·5 | 4 | 4·5 | 5 |
| 10 | 1 | 2052 | 2607 | 3577 | — | — | neg. | neg. |
| | 2 | — | neg. | neg. | neg. | neg. | neg. | neg. |
| | 3 | neg. | neg. | neg. | neg. | neg. | neg. | neg. |
| 20 | 1 | 792 | 881 | **1000** | 1155 | 1364 | 1674 | 2160 |
| | 2 | 1367 | 2160 | 5138 | neg. | neg. | neg. | neg. |
| | 3 | 5138 | neg. | neg. | neg. | neg. | neg. | neg. |
| 30 | 1 | 479 | 518 | 564 | 618 | 684 | 766 | 869 |
| | 2 | 684 | 870 | 1195 | 1907 | 4706 | neg. | neg. |
| | 3 | 1195 | 2720 | neg. | neg. | neg. | neg. | neg. |
| 40 | 1 | 320 | 364 | 389 | 417 | 449 | 489 | 533 |
| | 2 | 420 | 533 | 654 | 846 | 1198 | 2132 | — |
| | 3 | 654 | 992 | 2053 | neg. | neg. | neg. | neg. |
| 50 | 1 | 266 | 280 | 295 | 313 | 334 | 355 | 380 |
| | 2 | 332 | 380 | 444 | 533 | 680 | 892 | 1344 |
| | 3 | 462 | 593 | 892 | 1801 | neg. | neg. | neg. |
| 60 | 1 | 216 | 226 | 237 | 249 | 262 | 276 | 292 |
| | 2 | 262 | 293 | 332 | 383 | 452 | 552 | 706 |
| | 3 | 332 | 414 | 552 | 827 | 1680 | — | neg. |
| 70 | 1 | 183 | 190 | 198 | 207 | 217 | 227 | 239 |
| | 2 | 216 | 239 | 266 | 300 | 344 | 403 | 488 |
| | 3 | 266 | 320 | 403 | 544 | 837 | 1806 | neg. |
| 80 | 1 | 158 | 163 | 170 | 177 | 185 | 192 | 200 |
| | 2 | 184 | 200 | 220 | 245 | 281 | 314 | 365 |
| | 3 | 221 | 259 | 313 | 398 | 541 | 858 | 2026 |
| 90 | 1 | 139 | 144 | 148 | 154 | 159 | 166 | 172 |
| | 2 | 160 | 173 | 188 | 207 | 228 | 255 | 290 |
| | 3 | 188 | 216 | 255 | 314 | 399 | 554 | 908 |
| 100 | 1 | 124 | 128 | 132 | 136 | 141 | 147 | 151 |
| | 2 | 141 | 151 | 163 | 178 | 195 | 218 | 240 |
| | 3 | 163 | 186 | 215 | 256 | 314 | 422 | 581 |

TABLE II.—$a = 2$.

Total cost of unit light per hour, $y = \cdot01305$.

| Candle-Power. | Cost of hourly H.P. | WATTS. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 2·5 | 3 | 3·5 | 4 | 4·5 | 5 |
| 10 | 1 | 1195 | 1272 | 1466 | 1724 | 2106 | 2696 | 3882 |
| | 2 | 2095 | 3822 | — | neg. | neg. | neg. | neg. |
| | 3 | neg. | neg. | neg. | neg. | neg. | neg. | neg. |
| 20 | 1 | 482 | 515 | 554 | 598 | 650 | 713 | 788 |
| | 2 | 650 | 788 | **1000** | 1367 | 2160 | — | neg. |
| | 3 | 1000 | 1674 | 3820 | neg. | neg. | neg. | neg. |
| 30 | 1 | 303 | 318 | 335 | 354 | 374 | 398 | 424 |
| | 2 | 374 | 424 | 489 | 577 | 704 | 902 | 1255 |
| | 3 | 473 | 634 | 902 | 1529 | — | neg. | neg. |
| 40 | 1 | 220 | 230 | 239 | 249 | 260 | 273 | 286 |
| | 2 | 261 | 286 | 318 | 358 | 409 | 480 | 571 |
| | 3 | 318 | 382 | 476 | 634 | 946 | 1908 | — |
| 50 | 1 | 173 | 179 | 185 | 192 | 199 | 207 | 215 |
| | 2 | 200 | 215 | 234 | 257 | 287 | 319 | 362 |
| | 3 | 235 | 270 | 319 | 410 | 510 | 695 | 1146 |
| 60 | 1 | 142 | 146 | 150 | 155 | 160 | 165 | 171 |
| | 2 | 160 | 171 | 184 | 199 | 216 | 236 | 267 |
| | 3 | 184 | 207 | 236 | 276 | 332 | 412 | 546 |
| 70 | 1 | 120 | 123 | 127 | 130 | 134 | 138 | 142 |
| | 2 | 134 | 142 | 152 | 162 | 174 | 186 | 205 |
| | 3 | 152 | 168 | 188 | 215 | 249 | 296 | 366 |
| 80 | 1 | 104 | 107 | 109 | 112 | 116 | 118 | 122 |
| | 2 | 115 | 121 | 128 | 136 | 145 | 156 | 167 |
| | 3 | 129 | 141 | 155 | 174 | 197 | 228 | 282 |
| 90 | 1 | 94 | 95 | 96 | 99 | 101 | 103 | 106 |
| | 2 | 101 | 106 | 111 | 118 | 125 | 132 | 141 |
| | 3 | 111 | 121 | 132 | 147 | 163 | 184 | 224 |
| 100 | 1 | 82 | 84 | 86 | 88 | 90 | 92 | 94 |
| | 2 | 90 | 94 | 98 | 103 | 109 | 116 | 122 |
| | 3 | 98 | 106 | 115 | 126 | 138 | 156 | 174 |

TABLE III.—$a = 3$.

Total cost of unit light per hour = ·01708.

| Candle-Power. | Cost of hourly H.P. | WATTS. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 2·5 | 3 | 3·5 | 4 | 4·5 | 5 |
| 10 | 1 | 798 | 841 | 927 | 1019 | 1137 | 1293 | 1496 |
| | 2 | 1136 | 1505 | 2165 | 3246 | — | neg. | neg. |
| | 3 | 5163 | — | neg. | neg. | neg. | neg. | neg. |
| 20 | 1 | 347 | 364 | 383 | 403 | 427 | 452 | 482 |
| | 2 | 426 | 482 | 554 | 650 | 788 | 1000 | 1367 |
| | 3 | 554 | 713 | **1000** | 1674 | 5138 | neg. | neg. |
| 30 | 1 | 220 | 230 | 238 | 248 | 258 | 269 | 280 |
| | 2 | 258 | 280 | 307 | 340 | 380 | 431 | 498 |
| | 3 | 307 | 359 | 431 | 537 | 724 | 1095 | 2247 |
| 40 | 1 | 165 | 167 | 172 | 178 | 183 | 189 | 196 |
| | 2 | 183 | 196 | 210 | 227 | 246 | 270 | 297 |
| | 3 | 210 | 236 | 269 | 313 | 375 | 468 | 614 |
| 50 | 1 | 128 | 131 | 135 | 138 | 142 | 146 | 150 |
| | 2 | 142 | 150 | 159 | 169 | 182 | 194 | 209 |
| | 3 | 160 | 175 | 194 | 224 | 252 | 289 | 346 |
| 0 | 1 | 105 | 108 | 110 | 113 | 115 | 118 | 121 |
| | 2 | 115 | 121 | 127 | 134 | 142 | 150 | 160 |
| | 3 | 127 | 138 | 150 | 165 | 184 | 206 | 235 |
| 70 | 1 | 80 | 91 | 93 | 95 | 97 | 99 | 102 |
| | 2 | 97 | 101 | 106 | 111 | 117 | 123 | 130 |
| | 3 | 106 | 114 | 123 | 133 | 146 | 161 | 180 |
| 80 | 1 | 78 | 79 | 81 | 82 | 84 | 85 | 87 |
| | 2 | 84 | 87 | 91 | 95 | 99 | 103 | 109 |
| | 3 | 91 | 97 | 104 | 108 | 120 | 131 | 144 |
| 85 | 1 | 69 | 70 | 71 | 72 | 74 | 75 | 76 |
| | 2 | 74 | 76 | 79 | 82 | 86 | 89 | 93 |
| | 3 | 79 | 84 | 89 | 95 | 102 | 110 | 123 |
| 90 | 1 | 62 | 63 | 64 | 65 | 66 | 67 | 68 |
| | 2 | 66 | 68 | 70 | 73 | 75 | 79 | 81 |
| | 3 | 70 | 74 | 78 | 83 | 89 | 96 | 102 |

substitution in (2) and differentiation, the value of the candle-power could be obtained at which the cost of the unit light is a minimum. It is probable that an equation of the form $l = k\,(m - x)^n$ would approximately express this relation, $m$ being the candle-power at which the filament is practically destroyed. As this important question from its commercial aspect appeals with especial force to those working large installations who have also the necessary facilities for making the experiments, it is probable that this final problem will soon be solved.

## A NEW DYNAMO MACHINE.

BOLLMANN, of Vienna, has dispensed with the iron in the armature, and uses a disc composed of copper, which revolves between the opposite poles of twelve pairs of fixed electro-magnets. This system is founded on the well-known physical experiment in which there are induced, in a copper disc rapidly revolving between the half-keepers of a powerful electro-magnet, powerful electric currents which offer a resistance to the rotation. These so-called Foucault's currents can be conducted away for utilisation in a very imperfect degree only. Sir W. Thomson and Ferranti have given these currents a defined course, and have thus been able to employ in their alternating current machines a great number of magnets in a circle, since the induction in copper is not connected with any measurable retardation. They placed long strips of copper of a zigzag shape up and down in a circle, so that the angular distances of these deflections were equal to those of the magnets in the circle.

When these strips revolved between the opposite poles of the magnetic field, there were produced in them alternating currents, which could be used as such for the purpose of lighting.

Such alternating currents, however, could not be conveyed to a distance without a considerable loss of effect, but can be conveniently used close at hand only. In order to produce a continuous current, Bollmann has ingeniously constructed his disc of copper strips in the shape of a grating, in such a manner, that instead of one there are formed four separate circuits, which revolve alongside each other in a zigzag shape. The inductions in these four circuits succeed each other in such a manner that one is always in full action whilst another changes the current. In this manner a continuous current is produced by means of a commutator. In consequence of the application of numerous magnets, every part of the disc is constantly in the immediate neighbourhood of the magnets, and open to their fullest action.

In the machine as actually constructed, the disc is merely 12 millimetres in thickness; the poles of the magnets are therefore close together, whereby the magnetic field is rendered very intense. Thus a sufficient electromotive force is obtained with a very small quantity of copper in the disc. For a diameter of 60 centimetres the weight of the entire disc was only 30 kilos.

The results in comparison with other armatures were quite extraordinary and unexpected. There were introduced at first three glow lamps, each of 12-candle-power, and then gradually more and more up to 700. The variation of potential between 100 and 700 lamps was only from 3 to 5 volts. The total E.M.F. was about 50 volts, and with 700 lamps 1,000 ampères. No arrangement for the regulation of the current was in use. The machine and the motive power are self-regulating; the greater the number of lamps introduced the more are the ampères generated. The disc made 750 revolutions per minute. As this yield requires theoretically 70-horse-power (without allowing for loss), and the machine was not built strong enough, such a production being quite unexpected, no more lamps could be introduced. It is therefore impossible to say how many ampères the disc could have

yielded. The electromotive force can be regulated at will, and the disc can be constructed for arc lamp purposes. The resistance of the disc is only $\frac{2}{1000}$ ohm. The magnets and the disc remained cold.

The revolving armature ring, with its axle for a 1,000 lamp machine, on one of the systems now generally in use, weighs 9,800 lbs., of which 1,940 lbs. are copper. The entire Bollmann's machine weighs less than 1,940 lbs., of which only 64 lbs. are copper. It follows, of course, that such a reduction in the weight of the rapidly revolving armature greatly reduces the friction, and is very advantageous for the entire construction of the machine.—*Zeitschrift für Electrotechnik.*

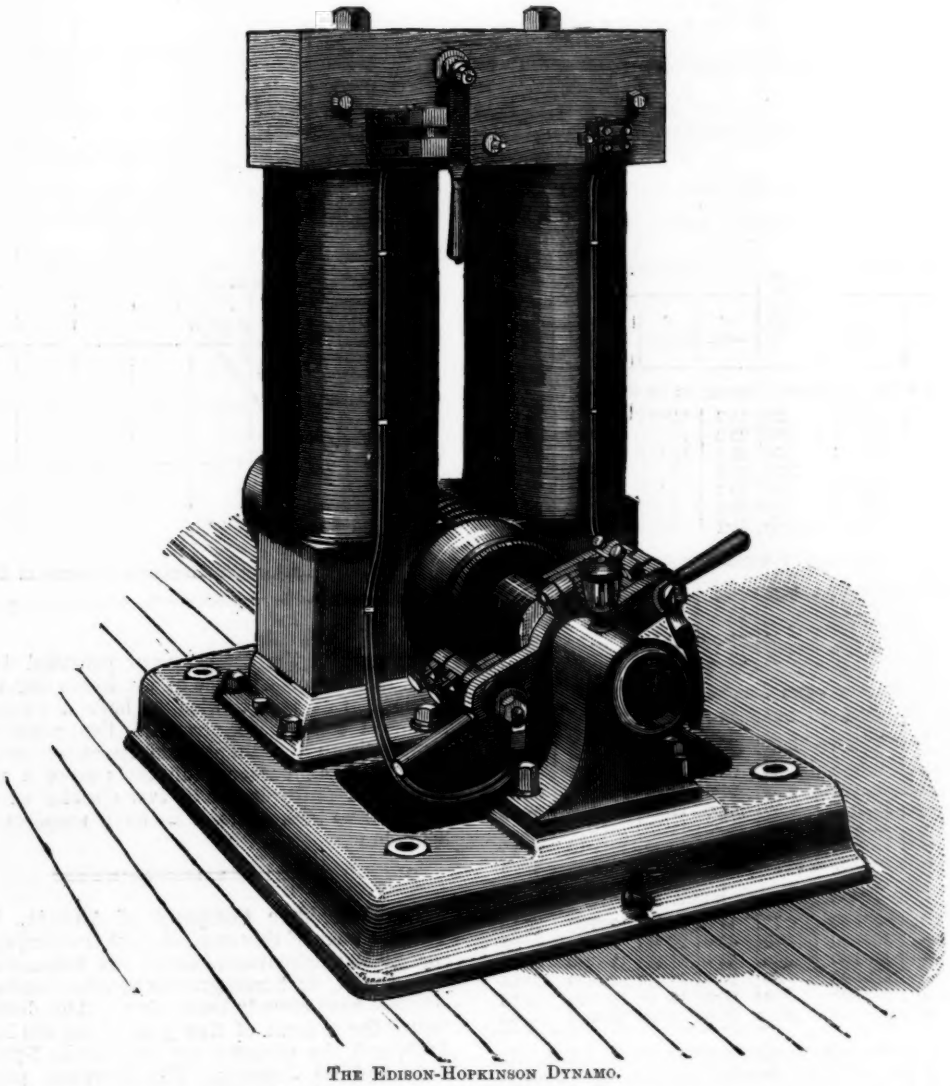
## ON THE TRANSFORMERS OF GAULARD AND GIBBS.

MM. GAULARD and Gibbs have proposed to effect the distribution of electric energy permitting each consumer to have a current of a different nature.

There are two systems of distribution with continuous currents: the one distributing the electric energy at a constant pressure and a variable current, the other with a variable pressure and a constant current. Distribution on either of these systems presents a grave inconvenience—the consumer is limited in the nature of the apparatus for utilisation sometimes by the electromotive force, sometimes by the current.

To obviate this inconvenience MM. Gaulard and Gibbs have proposed a system which enables each consumer to have a current presenting such qualities as he desires. The following is, in a few words, the principle of their system of distribution: they introduce into the circuit of an alternating current machine induction bobbins having special forms and arrangements with which we have not here to concern ourselves. These apparatus, which are simply transformers, render it possible to obtain secondary currents whose strengths vary according to the relative dimensions of the inducing and induced circuits.

Suppose, for instance, that we wish to effect lighting by incandescence. The number of the lamps in use will vary at each instant according to the requirements



THE EDISON-HOPKINSON DYNAMO.

## THE EDISON-HOPKINSON DYNAMO.

THE machine represented by the drawing, which is reproduced from a photograph, is that which was recently subjected to 14 days continuous running at the works of Messrs. Mather and Platt.

Full particulars respecting its remarkable performance, together with details of its construction, were published in the ELECTRICAL REVIEW for January 24th.

**Electric Lighting Bill.**—The Birmingham Electric Lighting Bill came before the examiner of the House of Commons as an unopposed measure last week, when it was found, after hearing the necessary formal proofs, that the standing orders had been complied with.

of the consumer. It is necessary that on lighting up a certain number of lamps all the others may not undergo any change of brightness. This result is obtained with a distribution at constant pressure or at constant current, but not on the system of MM. Gaulard and Gibbs. In support of our statement we give the figures found at the Turin Exhibition by M. Pietro Uzel and inserted in a note by M. E. Piazzoli, published in the Italian journal *Natura* (January 25th, 1885, p. 60).

We reproduce, says M. G. Roux in *L'Electricien*, in the form of curves the results found in the case of a large apparatus connected in series. The resistances of the external circuit are plotted out as abscissæ, and as ordinates, the corresponding values of the intensities (I, I′) of the potentials of the extremities (E, E′) and of the powers (E I, E′ I′) respectively in the inducing and induced circuits, as well as the yield $\frac{I' E'}{E I}$. The letters without an index refer to the inducing or primary circuit; the letters with an index refer to the induced, secondary or utilisation circuit.

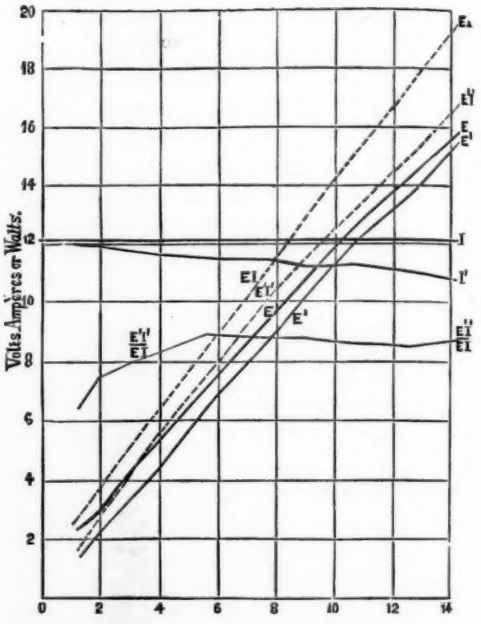
### CONDITIONS OF ACTION OF THE GAULARD AND GIBBS TRANSFORMERS.

| No. | Inducing Circuit. | | | Resistance in outer circuit. | Induced circuit. | | | Yield. $\frac{E' I'}{E I}$ |
|---|---|---|---|---|---|---|---|---|
| | E volts. | I ampères | E I watts. | | E′ volts. | I′ ampères | E′ I′ watts. | |
| **Small Transformer Connected in Series.** | | | | | | | | |
| 1 | 18·0 | 12·13 | 218·34 | 1·20 | 14·3 | 11·58 | 165·69 | 75·54 |
| 2 | 25·6 | — | 310·53 | 1·90 | 22·0 | 11·33 | 248·86 | 80·12 |
| 3 | 33·5 | — | 406·36 | 2·64 | 29·4 | 11·13 | 327·22 | 80·52 |
| 4 | 43·0 | — | 521·59 | 3·70 | 39·4 | 10·57 | 416·46 | 79·84 |
| 5 | 56·7 | — | 687·77 | 5·50 | 53·1 | 9·58 | 509·27 | 74·05 |
| 6 | 66·4 | — | 805·43 | 7·50 | 63·7 | 8·48 | 540·18 | 67·07 |
| 7 | 74·0 | — | 897·62 | 9·40 | 71·1 | 7·58 | 538·93 | 59·95 |
| **Small Transformer in Multiple Arc of Two Circuits.** | | | | | | | | |
| 1 | 23·4 | 12·13 | 283·84 | 0·40 | 9·7 | 24·03 | 233·28 | 82·18 |
| 2 | 48·0 | — | 582·24 | 1·12 | 22·1 | 19·68 | 435·91 | 74·87 |
| 3 | 63·0 | — | 764·19 | 1·90 | 29·6 | 15·46 | 457·62 | 59·88 |
| 4 | 72·6 | — | 880·69 | 2·60 | 35·0 | 13·11 | 458·85 | 52·10 |
| 5 | 80·0 | — | 970·40 | 3·30 | 39·4 | 10·19 | 401·49 | 41·37 |
| **Large Transformer Connected in Series.** | | | | | | | | |
| 1 | 23·4 | 12·13 | 283·84 | 1·24 | 15·0 | 12·02 | 180·30 | 63·52 |
| 2 | 31·4 | — | 380·88 | 2·00 | 24·0 | 12·00 | 288·00 | 75·62 |
| 3 | 53·0 | — | 642·89 | 3·80 | 45·0 | 11·83 | 532·35 | 82·81 |
| 4 | 70·0 | — | 849·10 | 5·50 | 65·0 | 11·73 | 762·45 | 89·80 |
| 5 | 93·0 | — | 1128·09 | 7·53 | 87·0 | 11·58 | 1007·46 | 89·31 |
| 6 | 107·0 | — | 1297·91 | 9·00 | 102·0 | 11·31 | 1153·62 | 88·88 |
| 7 | 126·0 | — | 1518·38 | 10·60 | 119·0 | 11·13 | 1324·77 | 86·66 |
| 8 | 145·0 | — | 1758·85 | 12·60 | 138·0 | 10·95 | 1511·10 | 85·35 |
| 9 | 159·0 | — | 1928·67 | 14·15 | 156·0 | 10·76 | 1678·56 | 87·03 |
| **Large Transformer in Multiple Arc.** | | | | | | | | |
| 1 | 43·0 | 12·13 | 321·60 | 0·72 | 17·0 | 23·50 | 399·50 | 76·59 |
| 2 | 88·0 | — | 1067·40 | 1·80 | 40·0 | 22·47 | 898·80 | 84·21 |
| 3 | 114·0 | — | 1382·80 | 2·40 | 54·0 | 21·87 | 1186·40 | 85·79 |
| 4 | 149·0 | — | 1107·40 | 3·50 | 70·4 | 19·65 | 1383·40 | 71·54 |
| 5 | 168·0 | — | 2047·80 | 4·70 | 80·5 | 17·00 | 1468·50 | 67·16 |
| 6 | 187·0 | — | 2268·30 | 5·40 | 91·0 | 16·60 | 1516·10 | 66·84 |

We see on referring to the curves that when the resistance of the induced circuit increases by 13 ohms, the difference of useful potential increases by 140 volts, the current diminishes by 1·26 ampères, and the power increases by 153 kilos. Therefore for an increase of resistance of 100 ohms (the curves of I′, of E′ and of E′ I′ being approximately right lines) the current would diminish by 9·7 ampères, the difference of useful potential increases by 1,077 volts and the power expended would increase by 1,100 kilos. per second, or 14·5 horse-power.

In an open circuit the difference of useful potential and the power expended must be considerable. We regret that no figures have been published for the cases where the external resistance is very great or where the circuit is open. In presence of such variations we do not see how the distribution of electrical energy can be usefully effected on this system. In fact, in case of lighting, are the lamps to be arranged in series or in derivation? If in derivation when any of them are lighted or extinguished, the brightness of the others will vary, since the resistance of the exterior circuit will vary. If they are arranged in series, why make use of transformers, since the intensity will be variable with their use and would be constant on their removal?

If we now cast a glance at the yield of the Gaulard and Gibbs transformers, we see that it is 88 per cent. in the case where the secondary current is of the same nature as the primary current, and if the curves of the




RESISTANCE OF THE EXTERIOR CIRCUIT IN OHMS.

(Each division represents 20 volts, 2 ampères or 200 watts.)

power and of the difference of potential do not coincide, it is in consequence of the losses due to transformation. But if we wish to have a current of less potential and more strength, the yield diminishes rapidly with the increase of resistance and does not even reach 41 per cent. In the case of a small transformer in multiple arc of two circuits where E = 80 volts, E′ = 39·4 volts, I′ = 10·19 ampères, and R = 3·30 ohms.

**The Telephone Company of Austria, Limited.**—The directors of this company are inviting applications for £9,500 debentures, being the balance of £50,000 5 per cent. first mortgage debenture bonds, of which £40,500 have already been taken. The debentures are issued for a term of five years from the 1st January, 1885, and the coupons are payable half-yearly on 1st July and 1st January. The company possesses exchanges, worked under exclusive concessions granted by the Austrian Government, in the nine towns of Prag, Graz, Trieste, Lemberg, Cracow, Czernowitz, Reichenberg, Pilsen, and Bielitz-Biala. This money is required for further extensions involving a corresponding further capital outlay during the course of the year.

**Free Telephonic Communication.**—It is understood that in the event of a telephonic exchange being established at Portsmouth, the Telephone Company will connect the police stations and several charitable institutions free of cost. Telephonic communication at present exists between the different police stations, and in several instances serious consequences have been averted in cases of fires, owing to the dispatch with which the alarm has been spread.

## ELECTRIC LIGHTING IN WARFARE.

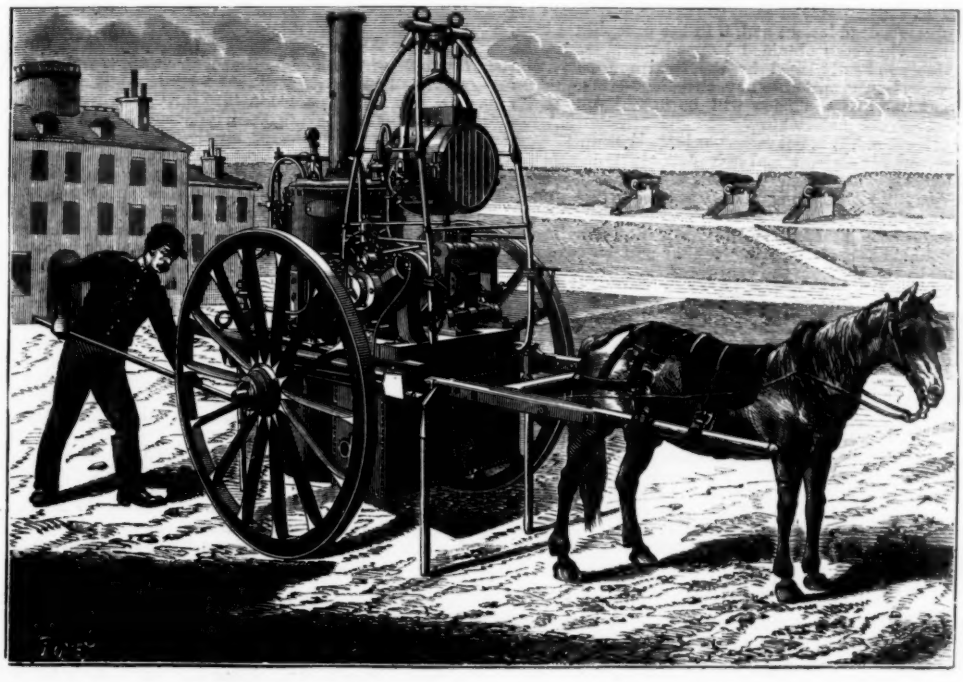
THE apparatus shown in the sketch consists of a two-wheeled vehicle drawn by a horse and carrying all the requisites for illuminating the works of the enemy. We learn from *La Nature* that the *materiel* comprises :—

1. A Field boiler ;
2. A Gramme dynamo, type M, driven directly by a three cylinder Brotherhood engine ;
3. A projector invented by Colonel Mangin, 0m.30 diameter, suspended for transport to a movable support. This support may, on reaching the required position, be removed from the carriage and placed upon the ground at a distance of about 100 metres from the machine with which it is connected by a cable. The projector is then turned round to a vertical position.

The Mangin projector is composed of a curved glass mirror, silvered upon its convex face, possessing remarkable optical properties which have caused it to be adopted by all the powers. The point of light which it emits has a perfect concentration. In front of the projector are placed two screens ; the first is a simple plane screen which is used when it is desired to give the point all possible concentration, the other is composed of cylindrical lenses which horizontally isolate the point so as to light up a broader tract of land.

The distance reached with the concentrated point is about 2,200 metres ; and the projector may be turned in any direction.

The various parts just described are easily taken apart and may be carried upon the backs of mules ; the only heavy piece being the boiler, which weighs about 450 kilogrammes.



**Lecture on Electric Lighting.**—An interesting lecture on this subject was delivered before the Liverpool St. Columba Society last week by Mr. B. H. Collins, of the Liverpool Electric Supply Company, Limited. Incandescent lamps of various illuminating power were exhibited, the current being supplied from primary batteries. The lecturer stated his belief that at no distant period the general adoption of the electric light might be anticipated, as its cost was reduced, and its efficiency ensured by competition.

## THE ELECTRIC LIGHTING ACT.

AN important stage in the movement for the repeal or modification of the Electric Lighting Act of 1882 is represented by the report to Lord Thurlow's committee, formed at the suggestion of the President of the Board of Trade, of its smaller and executive committee appointed to frame clauses in amendment of the Act. The main result of the deliberations of the committee is briefly explained in the opening remarks :—

"The executive committee have, after deliberate and careful consideration, arrived unanimously at the conclusion that the electric light companies should demand to be put simply in the same position as the gas companies are, both as regards their privileges and their obligations. The reasons which have led them to adopt this conclusion are—*in the first place*, that they believe no satisfactory solution of the question of general electric lighting can be arrived at by amending the Act on the basis of a modified purchase option clause, the existence of such an option in any form rendering it impossible to attract from time to time fresh capital to the enterprise, or indeed to attract any capital at all ;—and, *in the second place*, that the conclusion itself is clear and intelligible, and will at once commend itself to the public by its fairness and simplicity.

"The executive have decided, after a careful examination of the General Acts and the principal Special Acts relating to the gas companies, that the electric light companies may safely undertake the business of general lighting under conditions entirely similar to those of the gas undertakings ; and to carry out their recommendation they have prepared the draft of a Bill, which they now submit to the general committee, together with a brief memorandum of objects."

Following this is a statement containing in detail the principal reasons in support of the conclusion arrived at. First a contrast is drawn between the progress of electric lighting in England and in America respectively ; then attention is directed to the fact that in this country electricity has been a thoroughly practical success in ship lighting, where the industry is untrammelled by authority and conducted on the footing of an ordinary commercial business. Manufacturers in this country have also succeeded in creating a considerable demand for their goods for foreign countries and the colonies. Had it not been for such openings their manufacturing plant would have been comparatively idle.

The committee proceeds to remark that electric lighting in England has succeeded in isolated installations ; but house-to-house lighting on a large scale is hampered by the difficulty that it requires a wayleave under the streets, with some power of temporarily disturbing the surface. The Electric Lighting Act, 1882, has laid down the general conditions under which such wayleaves may be obtained, and by implication prohibits the local authorities from granting a wayleave on any other terms. The result is that not a single central station under these orders is working, or is in course of establishment, in London or in any of the large cities in the United Kingdom.

Having pointed out that the principle upon which the Electric Lighting Act, 1882, proceeds is that general electric lighting may be undertaken by local authorities, or by

companies, or by private persons, but that if the local authorities, whether because they regard the business as too risky, or from any other cause, decline the venture, and the work is undertaken by companies, the local authority which has refused to avail itself of its chance of undertaking the work at the outset, shall be able after a comparatively short period to acquire upon terms which it would be a misuse of ordinary language to call purchase all the property of the undertakers—the report states that not only has the purchase option clause deterred capital from the enterprise, but it has also furnished the local authorities with a distinct motive for declining the risk of embarking on electric lighting. It is the obvious policy of local authorities, having the option to purchase an undertaking on which they incur no liability, to wait until the risk is undertaken by others, so that they may be in a position to acquire the property only if and when the enterprise has proved successful.

The executive committee states positively that it is unable to devise any terms of option which shall avoid the double consequence of deterring capital and encouraging local authorities in the policy of abstention, remarking:—

"We have not omitted to observe the hint thrown out by Mr. Chamberlain, that while the community should be enabled to resume this 'monopoly' after twenty-one years, it should do so on terms which would at all events fairly recoup the undertakers for all legitimate outlay. If we were to formulate the terms which we should consider necessary *fairly* to recoup the undertakers for all legitimate outlay, including (as we should understand was fair) *compensation for risk*, we should only demonstrate the impossibility of framing a fair purchase option clause which would be workable. If really fair compensation for risk were included in the terms, it would only be in exceptional cases of success that the option would be of any use. In the majority of cases the option would be illusory, and the clause a dead letter; and, if in the exceptional case, where great success has been obtained by good management, the managers are liable to be displaced by the local authority, who may choose to exercise the option to buy them out—though at a high price—we think the condition will be mischievous in its tendency to paralyse the undertaking.

"If, on the other hand, it is not meant to include compensation for risk in the terms of purchase, and it is proposed that the unsuccessful undertakings shall bear the loss, while the successful ones are to be bought out on terms which will recoup the undertakers merely in cost price and interest, it is needless to point out that capital cannot be obtained on these terms; the terms would still have the double effect of deterring capital and encouraging local authorities to abstain from the venture at the outset.

"The purchase option clause was an experiment, and it has failed. It is absolutely without precedent.

"We observe that Mr. Chamberlain said, in answer to the deputation which resulted in the formation of the committee, that there were precisely the same restrictions in the case of tramways to those in the Electric Lighting Act. That is certainly not the case. To say nothing of the circumstance that in the case of tramways the price is left to arbitration without the prohibition against taking into account *goodwill* (or present profits), the tramway companies will be left in possession of their rolling stock and movable property; and, besides, the Tramways Act contains a very important clause disabling the local authority under any circumstances from working the undertaking. What they acquire by the purchase is the bare property, subject to the virtual obligation to lease the undertaking to some person or body of persons capable of working it. The competition is not likely to be serious; the old company will be in readiness with their rolling stock, movable property, and experience, and will doubtless obtain the lease at a rent representing fair interest for the outlay made by the local authority. It is indeed morally certain that in the case of a tramway, the purchase option clause, if exercised, will make little difference in the situation. The tramway company will retain the management, and probably make little or no sacrifice of annual income.

"The conditions of the Electric Lighting Act 1882 differ fundamentally. If their undertaking has been a disastrous failure, *cadit quæstio*, they bear the loss; but if it is struggling towards success (the utmost that can be hoped for in twenty-one years' time) the local authority may take the property and assume the management at a price which, if the option is not to be illusory, will be necessarily unfair.

"But we further contend that there is no real analogy between the cases of tramways and electric lighting undertakings. There were no intricate scientific questions involved in laying tramways, and it was not difficult to calculate approximately the capital outlay and the cost of working, tramways having been used in other countries before they were introduced here. Moreover, the use made by tramways of the streets and roadways is a very different thing from the use proposed to be made by the electric lighting undertakers. The tramways have a use of many miles of the public roadways which continually and seriously interferes with the ordinary public user of the street, causing much inconvenience and even risk.

"Another argument which has been used (though not by Mr. Chamberlain) is that the water companies are now practically masters of the situation, in the supply of one of the first necessities of life, and can only be bought at a very high price. It is not for us to argue the case for the water companies, but it may be pointed out that for many years the profits of the shareholders were by no means excessive. It is also to be remembered that the powers required by the water companies, extending as they do to the absorption of large natural resources, are very different in kind from the simple wayleave and power of temporary disturbance asked by the electric lighting companies.

"As to the purchase of the telegraphs by the Government it has been said that the terms were exorbitant. Under the Telegraph Act, 1868, the Postmaster-General was empowered, with the consent of the Treasury, to purchase the telegraphs on the usual terms of expropriation, that is to say (failing agreement) by arbitration. The interests of the telegraph companies were in fact purchased by agreement, but in the case of some (at least) of the railway companies, arbitration was resorted to. The suggestion really resolves itself into a grumble against the awards. It affords no reason why electric lighting undertakers should submit, by anticipation, to be expropriated on unfair terms, and without compensation for risks which are at present incapable of estimation. After all, it does not appear that the purchase of telegraphs has been otherwise than a good commercial bargain for the Government. It is instructive to know that with this fully before them, the Treasury sanctioned the arrangement which has been made between the Postmaster-General and the telephone companies for the compulsory purchase of their undertaking, and which provides that at certain fixed dates the Postmaster-General may give notice to purchase the various exchanges, and the agreement simply provides that the price to be paid shall, in case of difference, be determined by arbitration under the Common Law Procedure Act. This bargain, it may be remarked in passing, was made after (and notwithstanding) the Post Office had established by legal decision (founded on the terms of the Telegraph Act, 1869) an exclusive privilege against the telephone companies."

"The undertakings which really bear a fair analogy to electric lighting undertakings are those of their rivals, the gas companies. It seems necessary to recall a few of the leading facts in the history of this industry.

"Take the case of the Gas Light and Coke Company. This company was formed in 1809, about 16 years after it had been practically demonstrated that a house could be safely lighted by gas. By an Act passed in 1810 the Crown was authorised to grant them a charter giving them privileges for a term of 21 years. This charter was granted on the 30th of April, 1812. To quote from one of their recent reports: 'For years the rental was little more than nominal, and when at a later period it had succeeded in forcing itself into a position of some public utility and realising a fitful profit, the shares were almost always at a heavy discount. The dividend, when any was paid, seldom exceeded six per cent. The company's manufacture was in its early stage naturally crude and imperfect; the yield of gas from each ton of coal was very small, and for many years the price remained at about 15s. per 1,000 cubic feet.' But in the year 1816 their charter was extended for a further period of 30 years, and in the year 1819 they were incorporated with perpetual rights, and at a subsequent date their dividends were regulated in the manner which has since become universal. It does not appear that the dividends were regulated at all in the earlier periods of the gas companies, in fact not until the year 1823, that is 30 years after the introduction of gas lighting in a house.

"The first gas company formed out of London was at Preston, in Lancashire, in 1816. It commenced with a capital of £2,000; in 1817 the capital was £11,000; and in 1839, when the company was incorporated, the capital was raised to £30,000. Situated within a few miles of the cannel coal pits, and with exceptionally favourable local circumstances, they paid a dividend at the rate of 5 per cent. in 1817, none for the years 1818, 1819 and 1820; but in 1821 the dividend reached 6 per cent., which was the rate until 1825. It is clear that if the conditions of the Electric Lighting Act had been applied to gas in its infancy, this important and useful industry would have died a natural death in the early part of this century.

"The difficulties which gas had in its early times to overcome are greatly enhanced in the case of electric lighting by the circumstance that gas already occupies the field with its enormous fixed plant and invested capital. The position in which the electric lighting companies are placed in this competition is well expressed in the able and important report of the committee of the society called 'The Dynamicables.' 'Under the existing state of things the legislative conditions are incomparably more favourable to gas than to the electric light, and must enable it to undersell its rival in any competition there may be between them. The gas companies hold their powers in perpetuity, and they can afford a present loss or content themselves with diminished profits for a time in order to get rid of a troublesome competitor, the more so as they are entitled to make up any deficiency in the statutory dividends by increased dividends in future years; and the profitable nature of gas production would certainly enable them to do so.'

"It is sufficiently arduous for electric lighting to contend with gas upon conditions similar to those under which gas undertakings are now placed; but these conditions are at least the result of a compromise shown by experience to be possible, between the encouragement of enterprise and the security of the public against an undue use of monopoly.

"The existing gas legislation does in effect secure to the community the benefit of whatever profit is earned exceeding what is contemplated by the terms of the Act as a fair remunerative profit upon the original capital embarked in the enterprise. As to new capital, the auction clauses secure that it shall be raised at the minimum market rate; and any profit above that rate earned on such new capital goes to diminish the price, for the benefit of the consumer within the area.

"The auction clauses in the Gas Acts have been well devised for the precise object which the purchase option clause in the Electric Lighting Act was apparently intended to secure. Their operation is self-adjusting, according to the state of progress in the industry. They have succeeded in their object, so that without acting as a deterrent to investors they effectually impose a limit upon profits and give substantial benefit to the consumer.

"Moreover the sliding scale applied to gas companies, and by the amended Bill proposed to be applied to electric lighting companies, has restored to the gas companies that incentive to exertion which the hard and fast limit of a maximum dividend had taken away, with the result that such improvements are effected in the manufacture and distribution as to enable the companies to reduce their price; so that, at the present time, 16 candle gas is sold in London for as little as 3s. per thousand feet, a condition of things, there can be no hesitation in saying, that would not have been reached had the management been in the hands of public bodies not stimulated to improvement by the hope of pecuniary reward.

"The purchase option clause has conspicuously failed, and the executive committee have deliberately formed the conclusion that such failure cannot be remedied by any modification in the terms of the option. We believe that a purchase option clause without a corresponding guarantee, as in the case of the Indian railway contracts, must necessarily fail, inasmuch, as without the steady market value which could only be secured by a guarantee, the terms of option, if not illusory, must be deterrent to an extent out of all proportion to the benefit which can possibly accrue to the community.

"It will no doubt in any case be a long time before electric lighting can exercise a sensible influence in displacing gas. With a fair field of competition, but not without it, this is ultimately possible. A serious competition will in the meantime greatly improve the quality of gas supply, as, indeed, the threat of competition a short time ago did to a very sensible extent.

"The executive committee suggest, as another reason for preferring a limit upon the profits of undertakers, to a fixed period upon their existence, that limited dividends are more likely to attract steady and genuine investment, but will tend to discourage speculation on exaggerated and unreal expectations. It is indeed possible that on the basis of a fixed period, and unlimited profits in the meantime, a few speculative undertakings may be launched, with the result of disappointment to extravagant expectations, and of rendering it impossible at the critical time to attract fresh capital to the necessary extension of the enterprise.

"It is to be remembered that as electric lighting develops and advances in popular estimation, a large and increasing capital will be necessary to extend the system and make the supply still cheaper and more popular. This will be the critical period; and the ultimate success of electric lighting may not be attained until a large portion of the term of the purchase option clause has expired. It is impossible that the new capital can in the remainder of the term earn a fair commercial profit, as well as the means of providing a sinking fund for replacing the loss. The price loaded with the cost of providing a sinking fund would be prohibitive to extended consumption. Any proposed extension of the enterprise at such a time must necessarily be a failure, commercially; the undertakers would be unable to obtain fresh capital in the market, and if there remained any uncalled capital already subscribed, the calls could only be made by a cruel injustice to the shareholders.

"*If electric lighting undertakings are put on a footing of equality with gas, central station lighting will at least be tried on a scale sufficient to make the competition with gas serious.*

"The executive committee believe that such undertakings will, through difficulties, achieve ultimate success.

"The possibility of electric lighting as a large and popular industry now hangs in the balance, and if the committee should adopt our recommendation to demand that the electric lighting industry shall be put on the same footing as gas, we think it fair that the argument should be respectfully urged on the Board of Trade, that if this reasonable demand is not conceded, upon them will rest the responsibility for the failure of electric lighting in this country, and for the far-reaching consequences which may follow such failure. How far these consequences may extend we cannot presume to speculate. Even at the present moment we believe that the stimulus given to genuine enterprise in electric lighting by putting it on the gas footing would be considerable. If that enterprise succeeds, a further stimulus will be given to the application of science to industry which cannot but be important. Indeed, the encouragement of electric lighting at the present moment might be the turning point in the long-continued depression of trade under which the country has lately been suffering. Having regard to the keenness of competition which has now overtaken the long undisputed lead of this country in industrial progress—having regard to the circumstance that England is already distanced by America in the industry of electric lighting that this may be a step towards leaving to America a permanent lead in the new applications of science, and that America still holds in reserve the resources of the approaching extinction of her debt and the ultimate adoption of free trade, we think the Board of Trade will attach due weight to the importance of giving at this critical stage a fair field to the development of electric lighting enterprise.

"With these larger considerations the committee are not primarily concerned. As representing the interests vitally affected, the question for the committee is on what terms we can call for or invite capital to the enterprise of public electric lighting. We must keep in view that the electric lighting industry will in any case remain in possession of the smaller and safer field, which may be exploited on conditions not involving way-leaves through the streets. The electric light companies will continue in possession of the ship lighting industry, and on land they will be able to conduct electric lighting on a small scale as an expensive luxury for those who are able to pay for it. As to the larger field, if the industry can be worked only on the terms that property, which is the result of private money and enterprise of the undertakers—not consisting of an undertaking built upon land the subject of a concession, but as much their own as the property of an insurance company or telegragh construction company which has been obliged to apply to Parliament for powers affecting its constitution—is to be taken from them by the local authority without either a fair bargain or an Act of Expropriation by the Legislature of the day, we, as representing those whose capital is proposed to be at risk, feel bound to pronounce the words *non possumus*. We cannot, we dare not, we will not embark our capital on these terms.

"We may point out, however, that the local authorities, without an unfair acquisition of the property of the undertaking, will have, in any case, a large share in its future success. Apart from the considerations of refinement and health to the ratepayers, they will enjoy the substantial advantage of the creation of a considerable ratable property.

"Moreover, while unable to accept any purchase option clause, we think it quite right that all reasonable facilities should be given to local authorities to acquire electric lighting undertakings by agreement. A provision of this kind has already been embodied in the Public Health Act with regard to gas, and we have accordingly inserted in our draft bill a similar provision with regard to electric lighting undertakings. Such a provision will, we think, give local authorities who have declined the risk at the outset, a certain *locus pœnitentiæ* if they are wise in time by offering liberal terms to the undertakers when ultimate success is fairly assured. It is not improbable that at such a time the undertakers may be open to a fair bargain, so as to have the opportunity of transferring their capital for the development of electric lighting enterprise in a new field."

The effect of the draft Bill drawn by the committee may be gathered from the preliminary memorandum given under:—

"The main object of this Bill is to amend the Electric Lighting Act 1882, so as to place electric lighting undertakings in the same position as gas undertakings, both as regards privileges and obligations.

"The chief provisions are—

"1. That where electricity is not ascertained by meter, the consumer shall not use any lamp other than such as has been provided or approved of by the undertakers, or any lamp calculated to expend more electricity than he has contracted to pay for. This is done by clauses 3—6 of the Bill, which, in effect, re-enact (*mutatis mutandis*) the sections 18—20 of the Gasworks Clauses Act 1847, without the exception as to the use of burners made by section 12 of the Electric Lighting Act 1882.

"2. Section 18 of the Electric Lighting Act 1882, which expressly prohibited the undertakers from prescribing any special form of lamp or burner, is repealed; and instead, the proviso that where electricity is supplied by meter no local authority or person shall be at liberty to use any form of lamp or use the electricity supplied so as to interfere with the proper supply to other persons, is re-enacted substantively.

"3. Section 27 of the Electric Lighting Act, under which local authorities may, after the expiration of twenty-one years, purchase the undertaking by paying the then value of all suitable lands, buildings, works, &c., of such undertakers without any addition in price, in respect of compulsory purchase, or of goodwill, or of any profits, is repealed.

"4. The profits of undertakers are limited to the rate prescribed by the provisional order or special Act, or where no rate is prescribed to 10 per cent. per annum. The principle whereby dividends are increased or diminished in inverse ratio to increase or diminution of price, is introduced on the method of the sliding-scale applied to gas undertakings, except that having regard to the small price charged per electrical unit as compared with the price charged per 1,000 cubic feet for gas, the dividend is increased or reduced by five shillings per £100 in respect of every one farthing instead of 1d. as in the case of gas.

"5. New or additional capital in the undertaking to be offered to the public by auction, in accordance with the usual auction clauses applied to gas undertakings.

"6. The undertakers are to furnish a sufficient supply of electricity to owners or occupiers situate within 25 yards from the main.

"7. The undertakers are to supply electricity for public lamps

"8. Mains are to be kept fully supplied.

"9. Penalties similar to those of the gas Acts are provided in case of default by the undertakers.

"10. Local authorities to have similar powers of acquisition of the undertakings by agreement as are given them in the case of gas by the Public Health Act 1875, section 162.

"11. Penalties to be recovered summarily."

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**Proposed Telephone Exchange for Southampton.**—Efforts are being made by the Western Counties and South Wales Telephone Company with the view of establishing a telephone exchange at Southampton.

## ELECTRIC LIGHTING AT THE INVENTIONS EXHIBITION.

ONE of the most interesting features of the forthcoming international exhibition of inventions at South Kensington this year will be the very extensive application of electricity to the lighting of the buildings, and the novel use of glow lights in the place of coloured oil lamps for the illumination of the lawns and promenades of the grounds. It will enable many to realise more distinctly the very considerable additions that will be made in the number of electric lights employed this year, if a comparison is instituted, with the provision for the illumination of the Fisheries Exhibition. In 1883, then, there were 252 arc lights and 2,629 incandescent lamps used; this year there will be 464, or nearly twice as many arc lights, and 5,530, or more than double the number of incandescent lamps, without taking into account the many thousands of glow lights that, when the signal is given at dusk, will instantly turn the gardens into a scene as bright and wonderful as any conceived by the narrators of the stories in the Arabian Nights. The Lighting Committee is composed of Sir Frederick Bramwell, the Marquis of Hamilton, Sir Frederick Abel, Mr. W. H. Preece, Professor Dewar, Colonel Sir Francis Bolton (who again undertakes the direction of the illumination of the fountains), and Colonel Festing. The necessary arrangements have been made earlier this year than on previous occasions, and under the experienced superintendence of Mr. W. D. Gooch, who performed the duties of electrical engineer in charge of the lighting of the Fisheries and the Health Exhibitions, more than a third of the installations have already been completed, and it is confidently expected that all will be in readiness for the illumination of the exhibition and grounds on the day of opening, early in May.

The number of exhibitors of systems of lighting, twenty-one in all, is the same as at the Health Exhibition, but eight new names appear in the list, filling the places of companies defunct or of firms who from various causes are not among the competitors for the suffrages of the public. Taking the estimated candle-power of the lamps of both kinds into account, it appears that the illumination will be equal that of nearly 533,000 candles, the distribution being more exactly reckoned at 108,800 candles for the 5,530 glow lamps and 424,150 candles for the 464 arc lights. The latter vary from 200-candle power per lamp of seventy Varley lights, to be placed in the Eastern Arcade and Western Avenue by Messrs. Gaulard and Gibbs, to 5,500-candle power each for four brilliant Siemens lights in the conservatory. The highest estimated power for incandescent lights is that of 50 candles per lamp of 250 Bernstein lamps, shown by Messrs. Paterson and Cooper in the dining rooms. Of the Gülcher lamps, 200 exhibited by the Gulcher Electric Light Company, Limited, in the Chinese Restaurant and 250 of the Woodhouse and Rawson lamps are only to be worked to 16-candle power per lamp. Others by these makers and those of other systems are estimated at 20 candles each. Old London will be illuminated with both arc and glow lamps. Of the former kind five Mackie lamps of 2,500-candle power each will be so arranged as to produce the picturesque effect of moonlight obtained in the street and narrow lanes last year, while the shops and rooms upstairs will be lit with 300 incandescent lamps by Messrs. R. E. Crompton and Co. on two dynamos supplied by a 45-horse power Willans high-speed engine. In the Prince of Wales's Pavilion there will be 200 Swan lamps from one dynamo run by a 30-horse power Elwell-Parker high-speed engine. The Water Pavilion will have 250 glow lamps exhibited by Messrs. Goolden and Trotter. Everyone will remember the charming effect last year of the innumerable points of light marking out the arches of the long south gallery along which the visitor looked on entering from the Exhibition Road vestibule. Messrs. Siemens will again light this building, now called the Middle Court, with 1,080 Swan lamps, of which the light is estimated to be equal to that of 21,600 candles. A new court contiguous to this, and of equal width, enclosing the ground on which the bakeries stood as well as the space covered by a building appropriated last year to the meteorological section, will be illuminated by the Anglo-American Brush Electric Light Corporation with 1,000 Victoria incandescent lamps, from three dynamos run by a Kitson Parsons high-speed engine of 150 horse-power. The new court opening to the left of the entrance to these south galleries, and occupying the place of the first-class refreshment rooms, is to be supplied by the Edison-Swan Company with 1,000 of their own lamps, from dynamos served by a Mather and Platt high-speed engine of 190 horse-power. Messrs. Clark and Chapman light the grill room with 100 glow lamps, on two dynamos worked by one of their high-speed motor engines of 15 horse-power. The lighting of the aquarium is intrusted to the Gülcher Electric Light Company, who will use 800 glow lamps, computed to be worked up to 20 candle-power by two dynamos served by a high-speed Coalbrookdale engine of 120 horse-power.

Turning to the arc lights, the greatest number in any one building will be found in the enlarged east gallery, where Messrs. Thomson, Houston & Co. will exhibit 45 lamps of 1,000 candle-power and 18 of 600 candle-power each. The south central gallery will have 60 Jablochkoff lamps of 400 candles each; the central gallery takes 50 Gülcher lamps of 1,000 candles each, on dynamos worked by a Westinghouse high-speed engine of 120 horse-power; and the Queen's Gate annexe (where the Belgian exhibits were placed last year) will have 24 Brush lights of 3,000 candles each. Distributed in other parts of the exhibition there will be 24 sun lamps of 1,100 candles; 42 Pilsen lights of 750 candles; and, of the same power per lamp, 16 sent by Messrs. Paterson and Cooper; 24 by Messrs. Cordner, Allen & Co.; 10 Cardew and 10 Werner, exhibited by Messrs. Clark, Muirhead & Co.; eight Sennett lamps of 2,500 candle-power each; and 14 Bowman lamps of 700 candle-power shown by Messrs. Clark and Bowman. In the gardens six Hochhausen lamps of 3,000 candles each will be displayed at the masthead by Messrs. Goulden and Trotter; Sir Francis Bolton will employ 12 Siemens lamps, each of 3,000 candle-power, in the illumination of the fountains; and, lastly, in the electric light shed 16 Andrews lights of 800 candles per lamp will be used.

The steam power which is to keep in motion the generators of these floods of light will again be provided by Messrs. Davey, Paxman & Co., of Colchester. For the illumination of the grounds Messrs. Siemens will employ three engines, capable of about 1,000 horse-power work, by Messrs. Goodfellow and Matthews, of Manchester, supplied by Babcock and Wilcock boilers. In the absence of details of what has been done at the New Orleans Exhibition, it is thought that this will prove to be the most important experiment in electric lighting yet attempted.—*Times.*

## ELECTRIC LIGHTING FOR STEAMSHIPS.*

By ANDREW JAMIESON, Assoc. M. Inst. C.E. and F.R.S.E.

(*Continued from page* 237.)

### DISCUSSION.

SIR J. W. BAZALGETTE, C.B., President, said that the Paper was well worthy of the consideration of the members at the first meeting of their session.

Mr. A. JAMIESON desired, before the discussion commenced, to draw the attention of members to the electromotive-force curve of the "Victoria" compound-wound dynamo (see fig. 1, last week). That curve represented the electromotive force of the dynamo when generating currents from 0 to 120 ampères. It was very nearly a horizontal line throughout, and was a remarkable illustration of the rapid improvement that had been made in dynamo machinery within the last two years.

He wished to mention an experiment tried in connection with the ss. *Arawa*. There were two complete sets of plant, all in line on one sole-plate, either of which was capable of working more than one-half the number of lamps in the ship, the total number being three hundred. When only one hundred and fifty lights or less were required, one set of Ferranti plant was kept in action, but when more than one hundred and fifty or one hundred and sixty were necessary, the second engine was brought up to the same speed as the other, and the two were put into gear. Advantage had therefore to a certain extent been taken of the suggestions given by Dr. Hopkinson in his lecture on "Some points in Electric Lighting," delivered before this Institution, viz., "that two alternate current machines could be used for feeding one set of lamps when the forward and return circuits were common to both machines.

In the case of Siemens' frictional drive, the engine drove, through the intervention of a fly-wheel and a compressed paper pulley, a dynamo at fifteen hundred revolutions per minute. This arrangement got over the objection of the conservative marine engineer, for he need not see the dynamo revolving at that rate. as the whole apparatus was put into a small corner, and partially covered, so that he was thoroughly satisfied. It had given excellent results wherever adopted.

The rule which he had applied to the size of conductors for electric-lighting in steamships was not a mere arbitrary rule; it was the application of Sir William Thomson's to the particular case of short insulated wires. Mr. T. H. Blakesley, Assoc. M. Inst. C.E., had worked out this question in a paper read before the Society of Telegraph Engineers.† The author had worked out the same thing some time before in a similar manner for a particular class of leads, and their results agreed very closely. Seeing that not more than 100 ampères were required in any single main lead on board a ship, the sizes of the wires by which a ship could be fitted were few; so that, by means of a rule like that which he had mentioned, a contractor, with the table before him, could at once fit a ship without any trouble in computing formulas.

Dr. JOHN HOPKINSON said that the reason of the success in the compounding of the Victoria dynamo, and some others with which he was acquainted, was that the amount to be corrected by the series coils was small; that was attained by the fact that the field in which the armature revolved was exceedingly intense, and that the resistance of the armature was low. The error to be corrected being small, it could be reduced by the correction to an exceedingly small amount. In machines where the resistance was not so small, and a considerable amount of correction was required, it was not possible to obtain such a degree of accuracy. There was

* From the Proceedings of the Institution of Civil Engineers.

† "Journal of the Society of Telegraph Engineers and Electricians," 1884. Vol. xiii., p. 295.

another point with reference to the use of compound dynamos. There could, he thought, be no question that in cases where a single dynamo was connected to the circuit there was a very great advantage in using a self-regulating compound dynamo. If, however, two compound dynamos were connected to the same circuit, there was an instability in the division of the work between the two machines, so that one would be overloaded and the other do nothing. The remedy for that was easy. If there were two machines, instead of each machine correcting its own error by its current passing round its own magnets, the current from each machine was taken round and used for exciting the other. The plan, he believed, was an old one, and had first been adopted in the ordinary series machine, some years ago, in experiments made at the South Foreland; but it was worth re-calling now, when compound dynamos were in frequent use, and were likely to be connected together with the same circuits. The author had given what might be called a specification of what he considered the necessary insulation-resistance of dynamos. Dr. Hopkinson thought that such a hard and fast line was not desirable. The smaller the machine the higher should its insulation be. If the size of the machines were doubled, it might fairly be expected that its insulation-resistance—the surface being doubled or thereabouts—need not be more than a half, with an equal degree of efficiency and safety. With regard to the size of conductors, there were several points to be taken into consideration. One point was, that the conductor should be such that with its ordinary current it should not get excessively heated. Another was, that the distribution of the potential through the system should be constant; that it should not vary so as to endanger the lamps where it was high, or give an inefficient light where it was low. The third was that energy should not be wasted, and on the other hand, that too great outlay should not be incurred in the first instance in copper. Practically the last was really the consideration which in most cases should regulate the size of conductors. He thought that, in a very large number of cases, conductors were put in smaller than they ought to be, from mere motives of economy. He was sorry that the author did not go so far as Sir William Thomson's rule. He wished that everybody would go as far as that. It was very difficult to take the exceptional course of insisting on a little more expenditure in prime cost, when everybody was cutting down the cost too fine. Then, with regard to the size of conductors, it was possible that accidental connections might be made between the two conductors which took the electricity to the lamps, and took it away from them, and in that case an excessive current might pass through the conductors. To provide against that, cut-outs, as they were called, had been introduced which, if the current was excessive, would be fused before the wires became too hot. If the conductors were reduced at every branch to their minimum fair limit for the current which they had to carry, then at each branch cut-outs should be introduced. That involved a certain complication. Sometimes economy would be realised by making the smaller conductors of a larger size, and consequently avoiding the necessity of so many cut-outs. A sufficiently large conductor could be put to a single lamp to carry considerably more than the current for one lamp, enabling the electrician to dispense with a cut-out for each lamp, and to put one in for groups of three or four. That was more a question of cost and convenience than anything else, but he thought that economy would be realised by increasing the size of the smaller conductors, and diminishing the number of cut-outs. Another point referred to by the author was the relative advantages of two methods of wiring a ship; first, that of having a conductor to take the electricity to the lamps, and an insulated conductor to take the current back from the lamps; and secondly, that of having a single set of insulating conductors using the ship itself as a return. For his own part, he greatly preferred the former method, for this reason: it was not merely a question of having, so to speak, two strings to one's bow in the insulation; it was not merely that if there was a breach of insulation there was likely to be a breach between the copper and ironwork of the ship; but it went further; if such an accident occurred—if the earth insulation of one of the conductors broke down, and there was consequently a contact between the conductor and the body of the ship—if both systems were insulated, the electricians would, by proper arrangements, be aware of the fact that the insulation had given way before any danger or inconvenience occurred, and steps could be taken to remedy the defect. Besides, if there were two systems of conductors, both insulated, it was easy, when the machine was in operation, without interfering with the work in any way, to determine the insulation-resistance of both the positive and negative conductors. It was a great advantage to have it determined from time to time, so that if any defect was beginning to be developed steps might be taken to remedy it before any mischief could arise. For those reasons he felt strongly that, though good work might make a single-conductor system thoroughly satisfactory, still the least defect might always lead to serious damage without giving any warning; whereas in the other case, if the work were not so good, whenever a defect occurred notice was given of it before any mischief arose. With a little watching and attention the whole might be made perfectly secure. As to the use of alternate currents, when he had the honour of lecturing before the Institution, he pointed out that alternate-current machines, even if they were independently driven, had the power of regulating each other; that if they were coupled in parallel circuit they would tend to add their effects, and if in series they would tend to neutralise each other. Since then that point and other points connected with it had been experimentally verified, so that there could be no question about it. The synchronism of two alternate-current machines, when connected together, had been described by Mr. H. Wilde sixteen years ago;* but this Paper had been unfortunately overlooked by those interested in the subject. There was no need whatever for any clutching of the two machines. The machines themselves, when once started at the same speed, even though driven by independent straps, would control each other and drop into perfect synchronism, marching in step, even though each was making three hundred steps in a second, and with a power of 20 or more H.P.

Professor JOHN PERRY said that the paper was a very useful one, and he only regretted that it did not contain a little more of the author's own statistics. In speaking of compound dynamo machines, neither the author or Dr. Hopkinson had referred to the name of M. Marcel Deprez who really originated the principle of compound winding, and made it possible for a dynamo machine, kept running from a well governed engine at a constant speed, to develop almost exactly the same electromotive force, or to give the same light from every lamp, whether one hundred lamps were burning or only one of a circuit. True, Deprez regulated his dynamo in a different way from the latest compound-winding method; but the methods were all essentially the same in principle, and he regarded the discovery of this principle by Deprez as the greatest discovery since that of the dynamo machine. One of the most important points in the paper was that relating to the positions of the dynamo and of the engine in the ship. It was possible that mechanical engineers had not got sufficiently accustomed to the idea of gyrostatic action to take account of the pressures on the bearings of rapidly spinning bodies such as dynamo machines. He supposed that it was natural for electrical engineers to consider gyrostatic actions. They were accustomed to think of a magnet as a ship with a great number of compartments, there being in each compartment a rapidly-spinning body. Sir William Thomson first drew attention to this matter, and it was very natural for him to do so as he first explained why a top rose, why a stone rose on its longer axis when spun, or why an unboiled or rotten egg would not get up on the table when an attempt was made to spin it, whereas a well-boiled egg would get up. When the dynamo machine was turned about an axis, the armature tried to place its axis of spinning parallel to the axis of turning. In the first example taken by the author of a Siemens armature, the pressure on the bearings was found to be 3·6 lbs. If it were supposed that this dynamo machine was placed in the ship in such a position that it could get an ordinary translational motion of 10 feet amplitude, and taking the sixteen seconds periodicity of swing, it was found that the pressure on each bearing would be 12 lbs.; so that the pressure due to the cause generally considered by the engineer was three and a half times as great as the pressure due to the gyrostatic action. Further, he had considered the case of a ship having a swing, which was a simple harmonic motion, and it was well known that occasionally towards the end of a swing there was something very different indeed from the end part of a simple harmonic motion. So the pressure on the bearings might be many times greater than the gyrostatic pressure which had been spoken of. It should be remembered that the gyrostatic action was proportional to the greatest angular velocity of the ship, whereas the second action of which he had spoken, the one well known to engineers, was proportional to the rate at which the motion was altered. With regard to governing, the author had spoken of 10 per cent. fluctuation in speed as not attainable, and he had stated, as an example, that when one hundred lamps were being burned, and ninety-nine lamps were suddenly switched out, and only one lamp was left in, the difference in the speed for an instant was about 25 per cent. No one would be astonished at that. If 99 per cent. of the whole work was suddenly taken off the engine, it would be a most extraordinary stoppage of power, and probably in practice nothing like that sort of stoppage of light could ever occur except as a total stoppage. In any case, he had no doubt that if an electrical engineer would only ask a mechanical engineer for a minimum fluctuation of 10 per cent. in speed when there was, say, 80 per cent. fluctuation of power, he would get it. It was because they had not been in the habit of asking for good governors that electrical engineers had not obtained them hitherto. The electrical governors, sometimes spoken of as very good, appeared to him to be only comparatively good. They all depended on the principle that if there was an electro-magnet, and a certain current passing round that magnet, the magnetic field produced by the magnet was constant. Now it might be advisable to warn inventors that the magnetic properties of iron were hardly known to the writers of books and to electricians who had not made them a special study; and that measuring instruments which seemed excellent hypothetically were often practically very bad. And in regard to the action of strong electro-magnets differing in character from the weak ones used in Ayrton and Perry's solenoid ammeter and voltmeter, they might use the very best of the three best brands of Swedish iron, they might anneal it in a vacuum from such a high temperature as to make them afraid that the shape of the iron would be spoiled, they might take care that no file or other tool touched it afterwards, and if they tested it in a strong electro-magnet they would find that the field produced was not always

* Proceedings of the Literary and Philosophical Society of Manchester, vol. viii., p. 62; and Philosophical Magazine, Fourth Series, vol. xxxvii., p. 54.

the same for the same current. Let them, for example, increase the current from 0 to 20 amperes, and then see what the field was. Now, beginning with 30 amperes and coming down to 20, it would be found that the field was not the same. The character of the field depended to some extent on the past history; he wished it did not. That was a defect which would be found in all electric governors of engines, depending upon the action of a strong electro-magnet. As to another matter, the size of the leads, Sir William Thomson's rule led to a little over 3 square inches of copper in the lead per 1,000 ampères of current. Taking, however, the copper at £100 instead of £75 per ton, and 15 per cent. for interest and depreciation, the result was 2 square inches per 1,000 ampères. Mr. Blakesley took 1 square inch for 1,000 ampères, allowing for the cost of the insulation of the leads; but it seemed to Professor Perry that too much stress was laid upon the cost of the leads. Because Sir William Thomson, at the time when transmission of power for long distances was engaging attention, just after he had been discussing the transmission of power from Niagara to New York, based his calculations on what was then all-important, the cost of the copper leads, every electrical engineer now based his calculations on the cost of leads, although they might only be a few feet in length. The much more important consideration for single house and ship lighting was neglected, namely, ought not the light from the lamp to be constant? Given the best governor imaginable, whether electric or whether a mechanical governor, the dynamo machine being double wound, it only aimed at keeping the difference of potential constant at some one place in the system, so that a lamp at that place would be always of exactly the same brightness. But it did not follow that at a certain other place the light would always be of the same brightness. It depended on the number of lights between one place and another, and on the section of the leads. If a number of lights were switched out, there would be a different brightness in a particular lamp from its brightness before the others were switched out. Thus, if there were absolutely perfect governing in the dynamo room in the author's system, and if a room contained, say, 50 lights, fed by cables 200 yards in length from the dynamo room, and if 49 were switched out, the remaining lamp must have its potential increased 2·46 volts. Now, an alteration of even a fraction of a volt was annoying in a 100-volt lamp, so that an alteration of 2·46 volts was a very important matter. The only way in which this could be prevented was by lavishness in the cost of the copper cable, and this part of the total cost of a ship-lighting installation was comparatively small.

Mr. W. H. PREECE said there were, he thought, two satisfactory points in the paper, to which attention should be paid; the first was, that there was at any rate one branch of electric lighting that had turned out to be an unqualified success. Mr. Preece's first experience of electric lighting on board ship was in laying a cable across the Mediterranean, from Marseilles to Algiers. No one who had seen the facility that electric lighting afforded for those difficult operations connected with the laying and picking up of cables, would ever undertake the operation of submerging a cable without the adjunct of that marvellous assistant, and he was pleased to be able to say that there was not a single cable-ship now arriving in England that was not being completely fitted with electric lighting. A fleet of thirty-one ships was now maintained in different parts of the globe for the express purpose of looking after submarine cables, and the ships were all fitted with that contrivance. The ferry-boats across the Hudson River in connection with the Pennsylvania railroad were all fitted with electric lights. He had also crossed from Boston to New York, taking the water at the Fall River, and journeying by the steamer *Bristol*. In all the state cabins, saloons, and passages, the Edison light was constantly burning, and the arrangements were of a perfect character. A special engine-room was apportioned for this purpose; there was duplicate plant of engines and dynamos, and 250 16-candle lamps were scattered over the ship. The *Aurania* was fitted up by Messrs. Siemens, and it might be reasonably anticipated that a ship fitted up by so eminent a firm would have all the appliances that science and skill could furnish. There were 600 lamps worked by two 300-light self-regulating dynamo machines of Siemens patent, each driven by an 8 (nominal) H.P. (Caledonia) steam engine, by means of ropes and grooved pulleys; and two 60-light dynamos of similar construction, each driven by a 4 (nominal) H.P. Tangye vertical engine. Those engines and dynamos were used specially for the engine room and the stoke hole, and for what were called police-lights. They started from the moment the ship left New York, and continued running until her arrival at Liverpool, and during the whole of that time not a single flicker was observed; the lights were absolutely and perfectly steady, and at all times and seasons every part of the ship was thoroughly illuminated. There were, however, two or three defects in the saloon arrangements, which were due to bad joints. The author had pointed out the modes by which the electric currents could be distributed throughout a ship. The currents were distributed either by the one-wire system described in the paper, where the return was the shell of the ship, or they might be distributed by means of two wires—a method justly praised by Dr. Hopkinson. Again, they might be distributed by three wires, according to the mode employed by Mr. Edison in America, but also invented by Dr. Hopkinson for other purposes in England. It was essential in an installation of electric lighting to have the currents so distributed as to have an equal pressure all over. On board ship, and in a private house, a continued service was required, so that, in case of accident or disturbance of any kind, by turning on a little switch an energy could be elicited that would flood the whole cabin or room with light. Bad joints and leakage were a frequent source of trouble on board ship. Even on board the *Aurania*, when the ship rolled from side to side, one chandelier after another went out. The result was due to the ignorance, not, of course, of those who ordered the work, but of those who carried it out. It was a great satisfaction to know that electric lighting was improving, and that it was favourably received by the members of the Institution.

Mr. JOSEPH W. SWAN remarked that, looking at the incandescent lamp from a theoretical point of view, it was difficult to understand why as large a return of light for a given expenditure of electric energy should not be obtained from the white-hot filament as from the glowing crater of an arc lamp. In both cases the source of light was the same—electrically heated carbon. From the circumstance that the incandescent filament was not cooled by air currents, and the carbon of the arc lamp was so cooled, even a larger return of light from the filament might be anticipated; and this anticipation was not less warranted by the fact that the whole mass of the filament was uniformly heated, and that its entire surface emitted light, while the pencil of the arc light was unequally heated, and only a small part of its surface, to the degree of incandescence. Experiment confirmed this deduction. He had measured the light of an incandescent lamp when it was giving at the rate of close upon 2,000 candles per electrical H.P., or a candle for less than ½ watt. That was a larger return for energy expended than was usually obtained from a small arc; but it was all he could do to take the readings before the filament gave way under the disruptive action which attended this exceedingly high temperature. The practical lesson of this experiment was that, if the carbon filament of an incandescent lamp were heated to an excessive degree it would not last. On the other hand, he had had reported to him the case of an electric light installation in which a considerable number of the lamps had been in action during five thousand eight hundred hours, and they were still in use. He did not know the energy consumed for the light given in this case, but he felt pretty sure the lamps had not been highly heated. Probably as much as 4 or 5 watts instead of ¼ watt had been expended for every candle-light obtained. The question at what point between these extremes the cost of maintaining a certain required quantity of light would be least, was undoubtedly one of the greatest importance in relation to the economy of electric lighting by incandescent lamps. It was one which involved many varying conditions, and it had not yet been answered. To answer it completely, a number of carefully performed experiments were required, with numerous lamps of different kinds, lighted by currents of different kinds and strengths, constantly maintained for a considerable length of time. Experiments of the required thoroughness had never been made, and he doubted if really much more was known than that when the rate of 3 watts per candle had been attained, the lamp was living a fast life which would not last, and that below 4 watts per candle, and the lamp was not constitutionally bad, a green old age might be predicted for it. This he knew perfectly well was far from being a precise statement, but in the present state of knowledge it would not be safe to make it more precise. The question, however, was being considered in relation to ship lighting, and there it was evident what ought to be done. The two chief elements in the question were, the cost of lamps and the cost of power. Where power cost little it was more economical and convenient to take a small return of light for power expended than to exact a large return at the expense of more frequent lamp renewals. This was the case in ship lighting; for whether an amount of light equivalent to 200 candles per electrical H.P., or only 100 candles, was obtained, did not greatly affect the cost of light on board a steam-ship where 1 H.P. was developed by 2 lbs. of coal. Suppose, for example, that two hundred lamps were installed on a certain ship, and that all were lighted during an average of five hours a day, winter and summer—a length of time sufficiently in excess of the actual time to compensate for the few lamps lighted during additional hours. Assuming the indicated H.P. to be developed by 2 lbs. of coal, and that there was a loss of 33 per cent. in transforming the mechanical energy into its electrical equivalent in the lamps, it would result that from 3 lbs. of coal 100-candle light would be obtained during one hour in one case and 200-candle light in the other; or, to sum up the time and the coal so as to ascertain the cost in larger figures:—Every ten lamps expended 746 watts, and required 3 lbs. of coal per hour; 60 lbs. per hour for two hundred lamps, and 300 lbs. for the five hours a day, or nearly 1 ton of coal per week. Then, to get the same amount of light with such a low temperature of filament that only 100 candles per 2 H.P. resulted, just twice this quantity of coal would be consumed, namely 2 tons per week instead of 1 ton—a quantity so small that the breakage of a few lamps every week would more than equal its value. Or, supposing the average life in one case to be five hundred hours, and in the other five thousand, it would certainly be more economical to burn the larger quantity of coal and to have fewer lamps to renew. What the precise result would be in these two cases could not, as he had said, be stated with minute accuracy, for a good deal depended on the cost and quality of the lamps. But this at least was evident—the total cost of coal consumed was so small in either case, that if any considerable increase of longevity in the lamps, from, say, hundreds to thousands of hours, followed from the lower rate of light efficiency, and he did not doubt that would be the result, it would, on the whole, be better to burn the extra ton of coal per week in order to reduce the cost and trouble

attending the renewal of broken lamps. He therefore thought that for lighting steamships it was advisable to maintain the lamps at a moderate temperature.

With regard to the two modes of distribution described by the author, he concurred in Dr. Hopkinson's view that the two-wire system was the safest, and therefore the best. It was impossible to be too careful to ensure the maintenance of good insulation in the conductors, and there could be no question that the two-wire system contributed to that condition. A switch for a ship should be strongly made, and so simple and sure in action that it could not by any possibility get out of order. In his opinion there ought not to be any combustible material about it. The base to which the metallic fittings of the switch were attached should be earthenware, or some material as incombustible as earthenware. He said the same of fusible bridges, which should be fixed at every junction of a branch with a trunk wire. To render these the complete protectors they were intended to be, they should be both well designed and carefully fitted. Lead wires should never be used, unless the ends of the copper branch wire into which the piece of lead wire was inserted were soldered to the ends of the lead wire. If this could not be conveniently done, and he thought possibly it could not, then lead must not be used, for it was so soft, and so prone to oxidation, that it was impossible to make, or at least to preserve, good contacts between it and the ends of the wire by means of nuts and washers, however firmly they might be screwed "home" at first. A much better metal for the purpose was tin. It was more fusible than lead, less readily tarnished, had almost as high a specific resistance, and was sufficiently hard to enable a good contact to be made by means of screw connections. Tin could be drawn into excellent wire for this purpose, or pieces of a proper size and form, with enlarged ends or lugs, could be stamped out from sheets of pure tin. These were small details, but they had an important bearing on the safety, the efficiency, and the permanence of a system of electric lighting on board ship.

Mr. H. C. MANCE, C.I.E., said the author had stated that one hundred and fifty ships had been fitted with the electric light. It would be interesting to learn if the electric light was still used on all these ships, or, if not, the reason of its discontinuance.

As the question of joints had been mentioned, he might refer to a very small joint used in the Persian Gulf Telegraph Department, which might, he thought, be found of advantage to those who were entrusted with installations at home. He referred to joints above water. They were small India-rubber joints, which had been sent out for their India-rubber cable in small air-tight cases, so that one or two could be used as required. The copper conductor was first soldered, and the dielectric pared down to a taper on both sides. The jointing material consisted of a strip of pure India-rubber, a separator, which was very adhesive, and a red jacket. These strips were applied in succession, and the joint could be made in a few minutes. He had, as a temporary measure, put them down in 40 fathoms of water, and he had never found them give way. They were generally used to connect leads in cable boxes in the harbour, where the water rose within 6 inches of the cable ends. They had given no trouble, and he had found them very serviceable. The cut-outs mentioned by the author were no doubt correct in principle; but he thought that mechanically they were not exactly suitable for adoption on board ship. Those who were aware of the amount of cleaning and wetting that went on on board ship would know how important it was that the cut-outs should be safe from meddling and be dry, so as to avoid any surface leakage. He had occasionally used cut-outs to protect the cables from the effects of lightning. When unprotected, the delicate platinum spirals were easily broken, but they could be preserved by enclosing them. A cut-out should be dry, but at the same time easily visible. He had recently been shown the drawings of one which was protected by a little glass, so that it could be seen if any damage had occurred. It was contained in a piece of ebonite 2 inches long and 1 inch square, so that it would not interfere with the running of the wires along the ship's side. He presumed that the author meant, referring to insulation, 10 megohms per knot. Beginning with that it would be nearly certain to come down to less than 1 megohm per knot in the course of a year or two. The system of embedding in a grooved paraffined board was no doubt excellent, but it was not always practicable. By applying a serving of tape with India-rubber solution, the gutta-percha leads lasted three times as long. He had great trouble at one time with leads for testing purposes, in which he required greater insulation than would be needed for lighting, and he found that the addition of the tape gave excellent results. With 10 megohms per knot it was evidently intended to have a thin dielectric; there was, therefore, the more reason for protecting it thoroughly, so as to prevent any mechanical injury. He had tried many things, and he thought that a tape immersed in a mixture of white lead and tallow, which had been boiled carefully, formed an excellent and cheap preservative. He was surprised that nothing had been said about storage batteries. Was it to be understood, after all that had been written on the subject, that storage batteries were not of the slightest consequence?

*(To be continued.)*

**Telegraph Revenue.**—The receipts from April 1st, 1884, to March 14th, 1885, amounted to £1,680,000; from April 1st, 1883, to March 15th, 1884, £1,675,000.

## NOTES.

**Electric Lighting at Lloyds'.**—The lighting of the hoist at Lloyds' is now done electrically by means of E.P.S. accumulators. A set of cells will supply the current for about a fortnight, working 10 hours a day, after which the cells are replaced by another set fully charged.

**Electric Lighting at Messrs. Nicoll's, Regent Street.**—The installation at Messrs. Nicoll's has lately been increased by the addition of a set of accumulators supplied by the Electrical Power Storage Company, which are charged from the existing engine, and used to supply both arc and incandescent lamps run in parallel. The arrangement gives every satisfaction, and the Brush Ratchet lamp is shown to give a singularly steady light when worked off accumulators. The installation was carried out by the Electrical Power Storage Company.

**Electric Lighting at Greenock.**—By virtue of a Provisional Order granted by the Board of Trade to the Police Board of Greenock, an installation of electric light has been made in that town. Powers were taken to light the whole town, but for experimental purposes only a portion of Dempster and Roxburgh Streets, and a portion of Ann Street are being lighted. Professor Jamieson, Principal of the College of Science and Art, Glasgow, was appointed consulting electrician, and on his recommendation the offer of Mr. E. Beckingsale, of Little Bridge Street, London, was accepted for the carrying out of the work. The house for holding the dynamos and testing instruments has been erected at the Water Trust premises at Prospect Hill, and a turbine of ample power fitted up for driving the dynamos off a counter-shaft put in motion by rope gearing from the turbine. The two dynamos used are the "Victoria" compound shunt-wound machines, to give current for 100 incandescent lamps, and are coupled so that they can be put into circuit together at the will of the engineer by means of a switch. Swan incandescent lamps are used, and fitted up in the ordinary street lamps. It may be mentioned that the object of the experiment is not to see if the streets can be lighted by electricity, as that has already been proved at Greenock, but to ascertain the cost of and contingencies in supplying electric light as compared with gas; and nothing has been left undone to make the most perfect installation.

On Monday night last week, on the invitation of the electric lighting committee, a large number of gentlemen, consisting chiefly of members of Town Council, Police Board, and Harbour Trust and Corporation officials, met at the premises of the Water Trust to inspect the work, when Bailie Duff formally switched on the light. Bailie Duff, as convener of the electric lighting committee, occupied the chair, and after thanking those present for their attendance, proposed Mr. Beckingsale's health. Mr. Beckingsale, in responding, said the chief trouble they had had to contend with was the laying of cables, but the insulation resistance as tested by Professor Jamieson and himself had been satisfactory, notwithstanding the almost continuous wet weather of the past three months. His method had been to have electrical tests almost continuously applied, by which loss of insulation was detected as soon as a leakage occurred, however small it might be. He believed this was the first instance of electric cables being laid under a rigorous system of tests, as exacting as those applied to submarine cables. The instruments applied were the same, and so sensitive were the indicators, that on one occasion when a joint had been made in the cable a loss of insulation resistance was shown by the divergence of the spot of light on the scale, though the resistance of the insulating material amounted to eleven thousand million ohms; with great reluctance he had this joint cut out, when the cable, which was a short length, immediately resumed its normal condition. This degree of insulation was

only accomplished by the most rigorous adhesion to details, and care not to allow any dampness to remain in the insulating material, which was of an absorbant character. Professor Jamieson said the result of careful working was that the insulation resistance of the whole main cable with some ten lamps in circuit gave an absolute insulation resistance the other day when he tested it of seven thousand megohms, or quite seven thousand times as many as most underground lines for electric lighting of the same length given under similar circumstances. He hoped the pluck shown by the committee would attract the attention of other municipal authorities, and cause them to enquire how the installation had been carried out, and how it pleased them.

**The Electric Lighting Act.**—A meeting of the general committee formed to frame amendments of the Electric Lighting Act, 1882, for the consideration of the Board of Trade, was held at the offices of the Anglo-American Brush Electric Light Corporation, Belvedere Road, S.E., on Wednesday the 11th instant, the Rt. Hon. Lord Thurlow, chairman of the committee, presiding. The report of the executive committee and a draft bill amending the Electric Lighting Act, 1882, on the basis of the Gas Acts (dealt with in our other columns) were submitted, and the details of the same having been explained, it was resolved unanimously, on the motion of Viscount Anson, that the report of the executive and the draft bill be received and approved. The chairman was then asked to communicate with the President of the Board of Trade with the view to a deputation of the committee attending at the Board of Trade to learn his views on the proposals of the committee. The executive having been unanimously re-elected, the proceedings terminated with a vote of thanks to the chairman.

The report of the sub-committee referred to, and which will be found in our other columns, is evidence of a determination on the part of the parties concerned to persist in demanding all that they first asked at the hands of the Board of Trade, including the principal point of contention, the total repeal of the obnoxious 27th section or compulsory purchase clause, notwithstanding the presumably definitive assertion of Mr. Chamberlain that it was hopeless for them to anticipate so great a concession. Whether the President of the Board of Trade will be convinced of its necessity by the repetition of the demand and will reconsider his determination, it is hard to say; bearing in mind the pointed manner in which he assured the deputation introduced to him by Lord Thurlow that upon that point he had made up his mind, we incline to the belief that he will not. At the same time we have no hesitation in stating our opinion that the committee has completely succeeded in proving the justice of the claims made in behalf of electric lighting interests.

**The Electric Light and the Suakim-Berber Railway.**—The following apparatus have been shipped for use in connection with the laying of the Suakim-Berber railway:—Six sets of electric light apparatus, by Brotherhood, for six 1,000 candle lights, with six spare lamps and three spare lanterns to work on 4 ft. 8½in. gauge, trolleys and shears, crabs, ropes and brackets, 500 yards of cable, all complete for lamps, 4,000 ft. carbons, wrought iron dust proof case with each set; six sets of ditto, by Kitson & Co. (fitted on trolleys 4 ft. 8½ in. guage), each of six lights (Brush), and 800 yards of cable, with lamps, lanterns, carbons for 2,000 hours each lamp, poles, crabs, and appliances for lamps complete; six sets of Siemens' telegraphic apparatus with alphabetical instruments and telephones complete, two spare sets of telegraph and four spare sets of telephone instruments.

**Underground Electric Light Wires.**—At the convention held at Chicago recently, it was stated that 78 per cent. of the fires in New York caused by wires were from those underground.

**Electric Light and Weaving.**—Messrs. John Priestman & Co., Bradford, have adopted the electric light in certain parts of their mill and offices. The plant, consisting of a self-regulating dynamo and 90 20-candle Swan lamps, has been supplied by Messrs. Roper & Co. The motive power is obtained from the main shaft of the existing engine. In the weaving shed three lamps are suspended from the ceiling between each pair of looms, and are thus capable of lighting both.

**The Telephones of Europe.**—The *Ingénieur* publishes statistics of the telephone lines in operation in the different European countries at the end of 1884. We learn from this statement that there has been a uniform increase during the past year as compared with 1883. In Italy, ten cities possessed telephone lines at the end of 1884, against the same number in 1883; but the number of subscribers increased from 3,710 in 1883 to 5,301 in 1884, an increase of 30 per cent. In France, eleven cities had telephonic communication both in 1883 and 1884; the number of subscribers increased from 4,739 in the former year to 5,535 in 1884, an increase of 15 per cent. In Belgium, in five cities, the increase has been from 2,051 subscribers in 1883 to 2,443 in 1884, or 19 per cent. In Great Britain, London had 3,350 subscribers in 1884, against 2,565, in 1883, an increase of 25 per cent. Liverpool, Manchester, Southport, and Blackburn, had together 2,359 subscribers in 1883, augmented to 2,734 in 1884, or an increase of 17 per cent. For Sweden, the figures for 1882 and 1884 are available; they show the largest increase for any country. In 1882, only five cities, with 1,554 subscribers, had the telephone; in 1884, fifty-one cities, with 7,737 subscribers, an increase of 398 per cent. in two years. In Holland, in eight cities, we find 1,972 subscribers in 1883, and in 1884, in nine cities, 2,250 subscribers, an increase of 14 per cent. In Switzerland, in ten cities, in 1883 there were 1,778 subscribers, which figures rose in 1884 to twenty-seven cities, with 3,771 subscribers, increase, 112 per cent. In Russia there were in 1883, in six cities, 1,485 subscribers, rising to seven cities with 2,230 subscribers in 1884; increase, 60 per cent. The statistics for the German Empire for 1883 and 1884 are not yet published. There were 1,500 subscribers in Berlin in June, 1884. In Austria, at the end of 1883, eight cities only had telephone lines; there were 708 subscribers at Vienna in December, 1884. In Norway, on June 30th, 1883, two cities (Christiania and Drammén) had 755 and 150 subscribers respectively. In Denmark, Copenhagen had 516 subscribers in June, 1883. In Portugal there were, at the end of 1883, telephone lines in Lisbon with 343 subscribers, and in Oporto with 183 subscribers. Spain is the only country which has no telephonic communications as yet, but a law was recently passed by the Cortes reserving to the Government the telephonic monopoly.

**United Telephone Company v. Hearder.**—(Before Mr. Justice North, Wednesday).—In this action, in which the plaintiff company sought to restrain certain infringements of one of the Edison patents for telephones, an order was taken by consent under which the plaintiff company obtained an injunction with costs, and waived any right which it might have had against the defendants for damages, and agreed to discontinue another action brought against the same defendants concerning another patent. The defendants undertook to hand over to the plaintiff company two instruments which were referred to in the proceedings.

**Telephoning between London and Brighton.**—A firm of advertising agents in London received on Wednesday, direct by telephone from Brighton, the actual words and instructions respecting insertion of an advertisement in a daily paper of the next day's date. The whole transaction only occupied a couple of minutes. This is said to be the first practical use of the telephone for newspaper purposes over so long a distance.

**Telephone and Telegraph Wires.**—The Select Committee of the House of Commons appointed to consider the law relating to the control of telephone and telegraph wires met to take evidence on Thursday afternoon. Mr. Geo. Russell, Parliamentary Secretary to the Board of Trade, presided. Mr. Hunter, solicitor to the Post Office, was the first witness, and stated that he had had occasion to consider the right of the Postmaster-General and of the telephone companies, as to the construction and maintenance of electric wires. The right rests on an entirely different basis. The powers of the Postmaster-General depended on special Acts of Parliament, and those of the telephone companies depended on the general law. The Act which gave the Postmaster-General his monopoly was the Telegraphs Act of 1869. The first step the Postmaster-General had to take in the case of overhead wires was to obtain the consent of the authorities who had control over the roads over which the line was carried, and in the event of this being refused, he had the right of appeal. To attach wires to houses, he had to obtain the consent of the owners, lessees, and occupiers, and must give 21 days' public notice of the course the lines would take, and objections were referred tc the Board of Trade. The telephone companies had statutory powers as lessees of the Postmaster General, but under the general law they were able to put lines across the roadways provided it could be shown that there was no danger to the general uses of the line. Under the Electric Lighting Act, 1882, the electric lighting companies were absolutely prohibited from putting up wires without the consent of the local authorities, but electric lighting wires were much more dangerous than telegraph and telephone wires, because they were charged with a far greater force of electricity. Under the United Telephone Company's Bill, which had been introduced into the House of Lords this year, the company took power to carry their wires over roadways at a height of not less than 15 feet without the consent of the road authorities. The recommendations of the Post Office were that in future the Postmaster-General should merely give notice of his intention of putting up wires, and the objectors should have but one opportunity of making their objections. They thought the Postmaster-General's licencees should have the right of laying down underground wires, but nobody else, and they thought the Postmaster-General should have a veto with regard to the erection of overhead wires wherever he considered such wires would interfere with the public wires and the intended position of those which might be required for the public service. After some further evidence the committee adjourned.

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**Telephonic Exchange for Portsmouth.**—Portsmouth is now within measurable distance of a telephonic exchange. The subject formed the chief topic for discussion at the last meeting of the Chamber of Commerce, when the matter was introduced by Mr. A. W. White, who moved a resolution to the effect that a copy of the prospectus of the Western Counties and South Wales Telephone Company (which has taken over the business of the United Telephone Company in this district) should be sent to the Postmaster-General, submitting to him the desirability of reconsidering the terms previously proposed by the Post Office for an exchange at Portsmouth, and suggesting that if the telephone company could afford to accept these terms the Post Office should be able to do the work at the same price, as it would save the interest on the £300,000, dead capital, besides utilising the existing offices and staff; also that there should be only one exchange office for the whole district, and that the rates within the business radius should be uniform, and not preferential according to distance. Mr. Lewis, the manager of the Western Counties and South Wales Telephone Company, was invited to address the meeting. He explained that it was never his intention to establish four exchanges at Portsmouth, but it was his idea to open one at Southsea and one at Landport, so as to shorten the length of wires. He explained that the company would not increase the rates. With reference to all-night communication, that would cost about £120 or £130 per annum. If they had 100 subscribers he should feel disposed to only charge them £1 a year, and if they had 200 or 300 subscribers he would throw it in and charge them nothing. The matter then dropped.

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**Telephonic Tickets in Paris.**—The system of telephonic tickets, at half a franc, has been instituted in Paris, the holder of a ticket being entitled at any of the Paris post offices to hold five minutes' conversation with persons in any other post office, or at any of the Telephone Company's stations. The Telephone Company offers, at the same rate, conversations at any of its eleven stations with persons at any other station, or at the residence of any of its subscribers.

It is stated that efforts are being made by the chief telephone companies in London and other large towns to induce the Postmaster-General to sanction a substantially similar system in this country.

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**Telephonic Experiments.**—The interesting article published in our last and entitled "The Use of the Charging Battery in Telephony," is a translation of a part of a paper of Mr. Giltay's, from the "Maandblad voor Natuurwepengehappen." The paper to which the first note of our article refers ("The Polarisation of Telephonic Receivers"), is the same as that of which we gave so very short a notice in one of our recent numbers.

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**Telephonic Facilities.** — The National Telephone Company has had two call offices erected in the Exchange at Bradford, one of which communicates with the company's subscribers in the Bradford district, and the other with the subscribers at Leeds, Halifax, Dewsbury, Wakefield and Huddersfield. The former may be used by subscribers for three minutes free of charge, and by non-subscribers for the same period on payment of threepence. The payment for three minutes' use of the latter is sixpence. By this arrangement business men on 'Change may communicate with their own or other warehouses or mills in any of the principal towns of the West Riding on the spot.

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**Estimates for the Post Office Telegraph Department.**—The estimates for the Revenue Department for the year ending March 31st, 1886, were issued on Tuesday. Whereas £1,734,589 was granted for Post Office telegraphs last session, in the coming year the sum estimated is £1,839,816, an increase of £105,227. The chief sub-heads are account departments, £53,977; postal telegraph system, £382,943; central telegraph station, London, £220,075; district offices, London, £128,366; provincial post offices, £707,254; telegraph works, £201,540; purchase of sites and buildings, £20,500. All these items, save the last two, show an increase. In telegraph works there is a decrease of £29,460.

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**The Fishing Industry and the Telegraphs.**—Last week no fewer than 3,000 telegrams connected with fishing operations passed through the Girvan post office.

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**Latimer Clark, Muirhead & Co., Limited.** — The newly-issued catalogue of this eminent firm of telegraph and electrical engineers is replete with illustrations of the various apparatus required in the practical applications of electricity, and its value is very materially increased by the useful tables and formulæ given in its last pages.

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**The Thomson-Houston System.**—We are glad to see that the Thomson-Houston system of electric lighting, which was exhaustively dealt with in our notices of the Philadelphia Exhibition, is to be introduced into this country, Messrs. Laing, Wharton and Down, of Holborn Viaduct, having been appointed representatives here.

**A Model Electric Compass.**—The *Electrical World* describes "an electric automatic compass, the needle of which, by opening and closing the circuit, keeps a ship on the course laid down, without the intervention of any 'man-at-the-wheel.' All that is necessary is to set the compass—so the story goes—and the good ship makes a bee line for port."

**Heating by Electricity.**—Heating by electricity is frequently spoken of. Currents have not yet been found like natural gas, and even if they had it would be a waste to use them for heating, but, assuming steam engines to be used for generating in the first case, only one-ninth of the heat of the coal is recovered; then, say 25 per cent. of power is lost in the dynamo; and finally, 25 per cent. or more lost on conversion of the current into heat. Thus we get $0{\cdot}1 \times 0{\cdot}75 \times 0{\cdot}75$ of the heat of the coal $= 0{\cdot}05625$, or say, at best, $\frac{1}{20}$ only. Even when coal is burnt in an open fireplace, not more than half the heat is lost. In short, taking the expense of machinery, &c., into consideration, it is fair to assume that heating by electricity is at least fifty or sixty times more expensive than burning coal direct in the most approved stoves, and twenty-five to thirty times dearer than coal burnt in an open fire.—*The Engineer.*

**Obituary.**—The death is announced of Sir Curtis M. Lampson, whose name is intimately associated with the laying of the first Atlantic cable. Sir Curtis Lampson, who was the senior partner in the firm of C. M. Lampson & Co., merchants, Queen Street, City, was a native of America, having been born in Vermont, United States, on September 21st, 1806. When, in 1856, a company was at length formed to carry out the great undertaking, Mr. Lampson was appointed one of the directors and became vice-chairman. The cable was successfully laid on July 27th, 1866, and the Queen promptly signalised the event by flashing across it the message to the President of the United States—"The Queen congratulates the President on the successful completion of an undertaking which, she hopes, may serve as an additional bond of union between the United States and England." The important aid rendered by Mr. Lampson in that work was acknowledged in a letter from Lord Derby to Sir Stafford Northcote, who presided at a banquet given at Liverpool on October 1st, 1866, in honour of those gentlemen who had taken an active part in the laying of the cable. In the following month he was made a baronet. Last week he was elected a member of the Athenæum Club under the provisions of Rule II., which empowers the committee to elect to membership those who have rendered distinguished service in literature, art, or science.

**American Institute of Electrical Engineers.**—We have received advanced copies of the "Transactions" of this institute, which, it may be remembered, was founded in May last year. Among recent papers read have been:—"Notes on Phenomena in Incandescent Lamps," by Prof. Edwin J. Houston; "Underground Wires," by Mr. W. M. Callender, Callender Co., New York; "Synchronism," by Prof. Edwin J. Houston; "The Scientific City Street," by Mr. Rowland R. Hazard; "Experimental Method of Testing a Dynamo Machine," by Prof. C. F. Brackett; "The Earth as an Electric Circuit Completer," by Mr. Thos. D. Lockwood; "Telegraphing Without Wires," by Mr. S. J. M. Bear; "Chemistry of the Filament," by Mr. Edw. P. Thompson; "Depositing Vats in Series," by Mr. H. B. Slater; "The Patent Office: its relation to inventors and its needs," by Mr. C. J. Kintner, Chief Examiner of the Class of Electricity in U.S. Patent Office. The membership of the institute has reached 300, and there is every promise of its becoming a large and active society.

**Dissolution of Partnership.**—The dissolution is announced of the partnership between Messrs. Edmunds and Goolden, Victoria Mansions, Westminster, and Halifax, electrical engineers.

**The Electric Tramway at Blackpool.**—In the presence of the Mayor, and other members of the Blackpool Town Council, the first centre bar or conductor of the current for the electric tramway on the promenade was laid with some degree of ceremony on the 12th instant. Mr. Holroyd Smith, whose system is to be used, spoke confidently of the anticipated success of the new line, and the source of attraction which it is believed it will prove to visitors. The line is expected to be ready for opening by Whitsun week. Mr. Joseph Copley, of Lincoln, is the contractor under the corporation for the laying down of the line.

**Electric Fire Escapes.**—A hotel is to be built in Pittsburg seven storeys high, with the kitchen on the top floor and electric fire escape in every room. The escape is to be operated from the office. By touching a button there the guests are simultaneously aroused, every window thrown open, and a flexible ladder loosened that reaches to the ground.

**Forwards.**—Berlin, writes F. Uppenborn in *L'Electricien*, possesses already two central station installations, and it has been resolved to continue the brilliant lighting of the Leipziger Strasse, and of the Potsdamer Platz. Temesvar is still the most daring city; this *sea of darkness*, as the journalists called it, is transformed into waves of electric light. It is completely freed from gas lighting. The installation of a central electrical station by the "Continental Gas Association," is now contemplated at Vienna. This station will supply 12,000 Edison lamps, 4,000 of which are for the Hofopera, 3,000 for the Burgtheater, and 5,000 for other establishments in this quarter. These lamps will not be served directly, but by the intervention of accumulators. This decision is in consequence of the relatively great distance—2,000 metres—from the works, as the following figures will prove:—4,000 lamps correspond to about 3,000 ampères and 100 volts. In order to convey this current 2,000 metres with a loss of 10 per cent., the resistance of the 4,000 metres of conductors must be limited to 0·0033 ohm, and the volume of the conductor would be consequently 8,000 cubic metres, and its weight 712,000 kilos. The cost of the unwrought copper for this installation would therefore, at the price of $2\frac{1}{4}$ francs per kilo, reach about 1,600,000 francs. This shows clearly that a direct supply or rather an arrangement purely in quantity is not an admissible solution. Turrettini intends, therefore, to construct machines of 700 volts and 240 ampères, with which he will charge accumulators connected in series near the places of consumption. The 12,000 lamps will be served by accumulators on Calo's system, which, according to experts, have given the best results for about fifteen months at the Rothschild palace. The success of this bold enterprise turns exclusively on the duration of the accumulators. The estimate for the installation is 3,750,000 francs, and the hourly cost per lamp will be fixed at 0·10 franc.

**Electrical Patents in the United States.**—Mr. T. D. Lockwood, writing in the *Electrician and Electrical Engineer* of New York, gives the following statistics relative to the issue of electrical patents from the U. S. Patent Office during the year 1884:—The total number of patents issued for electrical inventions during 1884 is 1,166. Total number of patents issued in 1884, 18,799. For telegraphs, 121; alarums, 98; electric lighting, 177; sources of electricity, primary or otherwise, 164; conductors, 58; insulating materials, 64; underground systems, 3,173; construction, 44. Special systems of utilisation:—Clocks, time regulators and distributors, 30; electric distribution and meters, 23; remedies against induction, &c., 11; electric gas lighting, 12; lightning arresters, and protectors against abnormal currents, 19; transmission of power, motors and railroads, 45; electro-magnets, 6; galvanometers and measurements, 5; switchboards, and apparatus therefor, 13; telephones, and telephonic appliances, 179; miscellaneous applications, 89.

**International Inventions Exhibition.**—His Royal Highness the Prince of Wales, President of the International Inventions Exhibition, has fixed Monday, the 4th of May, for the opening of the exhibition.

There are but few persons who went to the Fisheries and Health Exhibitions who will not remember the excellent manner in which these buildings were electrically lighted. The executive council have decided to light up the whole of the buildings of the Inventions Exhibition by this most excellent and best of all artificial lights, and the contract for supplying the whole of the motive power for driving the electric light machinery has been placed in the hands of Messrs. Davy, Paxman & Co., engineers, of Colchester, who, it will be remembered, so successfully supplied the power at the two previous exhibitions. The plant (ten steam boilers and five powerful steam engines) as supplied by Messrs. Davey, Paxman & Co., last year, is retained; and, besides this, eight additional large locomotive boilers will be provided by the same firm. These new boilers will all be made of best quality steel, and have all the most modern improvements. Each boiler will contain 610 square feet of heating surface, and these eight boilers with easy firing can evaporate 36,600 lbs. of water into steam per hour. The total number of boilers will be eighteen, so that 110,000 lbs. of water can be made into steam of 100 lbs. pressure per square inch per hour. It will thus be seen that an enormous amount of power is provided for the executive council by this eminent Colchester firm, whom we congratulate upon being again selected for this important undertaking.

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**The Electrical Exhibition at the Paris Observatory.**—The tickets of admission to the above exhibition have just been issued by the Société Internationale des Electriciens and M. l'Amiral Mouchez. These tickets are gratuitous, and may be obtained on application to the members of the society. The exhibition will be open daily from noon to six o'clock, and from eight till eleven o'clock, from Sunday, March 22nd, until Sunday, March 29th, inclusive. The inaugural meeting, at which the members of the society, the exhibitors, members of the Government and kindred bodies will be present, will take place this evening at nine o'clock. The exhibition, which promises to be most interesting, has more than 120 exhibitors, representing all branches of electrical industry. The lighting of the saloons and entrances of the Observatory will be effected by 500 incandescence lamps and 50 arc lamps. During the exhibition the following series of meetings will take place:—Sunday, March 22nd, 9 o'clock: "Application of Electricity to Astronomical Observations," M. C. Wolf. Monday, March 23rd, 8.30: "Telephony," M. L. Maiche. At 9.30: "On Telephonic Induction," M. C. Elsasser. Tuesday, March 24th, 9 o'clock: "Electric Lighthouses," M. A. de Méritens. Wednesday, March 25th, 8.30: "Accumulators and Transformation of Voltaic Electricity," M. P. Samuel, Experiments by M. E. Planté. At 9.30: "Application of Electricity to Military Operations," M. Le Roux. Thursday, March 26th, 9 o'clock: "Application of Electricity to Medicine," Dr. Boudet, of Paris. Friday, March 27th, 8.30: "Galvanometric Measuring Apparatus," M. E. Lippmann. At 9.30: "Application of Electricity to Railways," M. P. Jousselin. Saturday, March 28th, 9 o'clock: "The Electrical Transmission of Energy by the Various Methods of Automatic Distribution," M. E. Cabanellas. Sunday, March, 29th, 3 o'clock: "Application of Electricity for Barometrical purposes," Dr. Marié Davy. At 9 o'clock: "Telegraphy," M. E. Baudot.

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**The "Arcadians."**—A club with this name having been formed amongst the staff and pupils of the firm of R. E. Crompton & Co., electric light engineers, Chelmsford, the hon. secretary of the cricket division will be happy to receive communications from hon. secs. of other cricket clubs in connection with electrical or engineering firms, to arrange matches during the coming season.

**Secondary Batteries.**—Replying to Mr. Sellon's letter, given in our last issue, Mr. Maxwell-Lyte writes:—"As to Mr. Sellon 'challenging' me to prove that M. Planté anticipated him in the employment of plates of the form described and claimed in Mr. Sellon's patent of the 10th September, 1881, I can only say that I did not and do not wish to prove anything of the kind. What I said and persist in saying is that M. Planté's electro-chemical roughening of plates, described in his patent of 10th May, 1873, debars Mr. Sellon from claiming broadly roughening by *any* chemical process, and therefore as a consequence that Messrs. Elwell and Parker are entitled to specifically claim roughening by nitro-sulphuric acid. And I would here again draw attention to the fact that Mr. Sellon seems entirely to ignore Messrs. Elwell and Parker's claim to the use of *nitro-sulphuric* acid as shown in the following extract from their patent, viz.: 'There is also formed upon the electrodes during their preparation in the mixed acid solution, aforesaid, sulphate of lead, to any desired extent, and this salt deposited on the roughened surface subsequently becomes converted during the action of the battery into peroxide of lead, or spongy lead, according to the direction of the current. According to this part of our invention the electrodes are prepared in about 48 hours, more or less, and when placed in the battery cell such cell is of full storage capacity, whereas an ordinary Planté battery is not at its full capacity until after a lengthened period of working.' Here then we have an improvement on the Planté battery which being merely a variety constitutes a recognition of the Planté system. Surely Mr. Sellon cannot octupus-like cover all this with the few comprehensive words, 'any chemical process?'"

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**Liquidation Proceedings.**—A meeting in regard to the affairs of Armand Levy, Goswell Road, and Grosvenor Road, Highbury New Park, India rubber merchant and dealer in electrical instruments, is to be held at 34, Lincoln's Inn Fields, on April 16th.

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**Lighting of the Cape Parliament House.**—Mr. Charles Hortsek, who was sent out from England last year to install the electric light in the New Houses of Parliament, Cape Colony, has, according to a contemporary, now completed the work, which gives great satisfaction. At a public trial the light was pitted against gas, and the palm was awarded to electricity. The Houses consist of a Council Chamber and an Assembly Chamber, the latter only being as yet lighted by electricity. Provision was, however, made in laying the conductors for an extension of the light. There are eight electroliers in the chamber, each containing twelve 16-candle Edison lamps. In addition to these there is a standard lamp in the Speaker's room, another in the library adjoining, a third in the clerk's room, three in the roof protected by wire netting, and fifteen in the engine-room. The current is supplied by an "L" Edison dynamo for 150 lamps requiring 19 horse-power. The dynamo is worked direct from the fly-wheel of a "Robey" 10 horse-power (nominal) steam engine by means of a leather link belt. The dynamo runs at 900 revolutions per minute to give the 110 volts required to work the lamps. The main cable is 150 yards long and is laid underground in wrought iron pipes of 3 in. internal diameter, and watertight. Four of these cables are laid; two being spare ones for the contemplated lighting of the Council Chambers. All the wires have been covered by Mr. Hortsek with wooden mouldings, and where they touch a wall or gas pipe they are sheathed in India rubber tubing in addition to their own insulation. In order to make the installation as simple as possible, Mr. Hortsek arranged the lamps in five branch circuits.

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**Maiche's Microhmmeter.**—We gave a brief note respecting this apparatus in our last week's issue. We believe that our readers can obtain any further particulars by applying to L. Maiche & Cie., Rue Louis Grand 3, Paris.

**Walter T. Glover & Co.**—We are requested to mention that on the 20th instant Messrs. Walter T. Glover & Co., electrical wire and cable makers, will remove from their present city offices at 25, Booth Street, Manchester, to their new and commodious offices in close proximity to their three works: Bridgewater Street, Broughton Road, Salford Electric Wire Works, and Springfield Lane Cable Works, Salford. Their new postal address will be: Walter T. Glover & Co., Salford, Manchester.

**The Chicago Electric Light Convention.**—The result of the Electric Light Convention, held at Chicago on the 25th and 26th ult., is the formation of a National Electric Light Association, the members of which "shall be companies, firms, or individuals operating electric light plants, or manufacturing electric lighting apparatus." An executive committee is to meet from time to time to gather and prepare information on all topics of interest, and submit reports at each meeting of the association, which will hold at least one general meeting each year.

**The Electrical Regulation of Engines.**—On Tuesday evening, the 24th March, Mr. P. W. Willans will read a paper before the Institution of Civil Engineers, entitled, "The electrical regulation of the speed of steam engines and other motors for driving dynamos."

## NEW COMPANIES REGISTERED.

**Medical Battery Company, Limited.** — Capital £100,000 in £5 shares. Objects:—To take over the businesses of manufacturing and dealing in electric, magnetic, and medical appliances, carried on by the Pall Mall Electric Association, Limited, at 21, Holborn Viaduct, and by Mr. Cornelius Bennett Harness, at 205, Regent Street. Signatories (with one share each)—H. Barrett, Dulwich; G. F. Wills, Crewkerne; C. G. Elers, 87, Wandsworth Road; C. B. Harness, Lavender Hill; J. A. Winter, Bridgwater; W. G. Johnson, 64, Cambridge Terrace, Hyde Park; E. Crick, Reading Villa, Dalston Lane. Registered 16th inst. by Mr. C. Doubble, 14, Serjeant's Inn, Fleet Street.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Maxim-Weston Electric Company, Limited.**—The annual return of this company, made up to the 4th inst., was filed on the 11th inst. The nominal capital is £250,000 in 10s. shares. The number of shares taken up is 200,000, and upon these 10s. per share has been called and paid. Five shares have been forfeited, but no amount is recorded as having been paid thereupon.

**Brush Midland Electric Light and Power Company, Limited.**—The annual return of this company, made up to the 24th of December, was filed on the 10th inst. The nominal capital is £70,500 divided into 21,800 shares of £2 10s. each, and 3,200 shares of £5 each; 19,052 of the former and 3,200 of the latter have been taken up. The full amount has been called upon the £2 10s. shares, and the £5 shares were issued as fully paid. The calls paid (including £255 paid on 170 shares forfeited) amount to £43,788 and considered as paid to £16,000, and the sum of £4,097 remains unpaid.

**British Spiral Telephone Wire Syndicate, Limited.**—At an extraordinary general meeting of this company, held on the 11th inst., at 1 and 2, Victoria Chambers, Nos. 55 and 56, Chancery Lane, it was resolved to wind up the company, it having been proved that, by reason of its liabilities, the company could not continue its business. Mr. William Downie, of 28, Southampton Buildings, W.C., was appointed liquidator. The resolutions were duly filed on the 14th inst.

**Standard Electric Light and Power Company, Limited.**—At a special general meeting of this company, held at the offices, 31, Lombard Street, on the 30th December, a resolution was passed adopting an agreement of 22nd December between John Berger Spence of the one part, and Richard Houghton Baillie, Charles Stuart Blair and Thomas Rome of the other part. The resolution was confirmed on the 15th January and filed on the 13th inst.

**William Elmore, Limited.**—The second return of this company, made up to the 18th November, 1884, was filed on the 22nd of the same month. The nominal capital is £16,000 divided into 8,000 A and 8,000 B shares of £10 each. 3,989 A shares have been taken up, and upon 3,909 shares the full amount has been called, the remaining 80 A shares being allotted to the vendor in lieu of 8,000 B shares. The calls paid amount to £37,455, and considered as paid to £8,000, the sum of £1,635 remaining unpaid.

## CITY NOTES, REPORTS, MEETINGS, &c.

### South-Eastern Brush Electric Light and Power Company, Limited.

AN extraordinary general meeting of this company, called in pursuance of a requisition by shareholders, was held at the offices, Cow Cross Street, on Friday last week. Mr. T. Fry, the chairmain of the company, presided over a small number of shareholders.

Mr. George Offor, jun., the secretary of the company, having read the notice calling the meeting,

The Chairman said: Gentlemen, we have reached to-day a very important crisis in the affairs of this company, and it is for you to say whether it shall be put an end to suddenly, and, as I think, ignominiously, or whether you will allow it time to go out of existence with something like credit and dignity. Now, I do not suppose that I shall influence the vote of anyone who has come here who has already made up his mind: those, I believe, who are bent on self-destruction seldom listen to reason. But I have this to say for the benefit of those who are not present, that the position in which we find ourselves now, and that condition of things which has been brought about by those who are opposing the board—("No!")—has left this company a very poor chance of realising the assets that it possesses, when we find that those who take upon themselves to advise the shareholders announce publicly that the chances of making any terms that would be beneficial to the company are "beyond reasonable expectation," when we also hear that they are informed that the chances of selling the Colchester installation, because it does not happen to pay at the moment, is a thing that we cannot expect. Well, now, we think otherwise. With regard to that Colchester installation, whatever may be thought of it, we say we have proved to a demonstration the success of our system; all that is wanted is the more extended application of that system to make it a commercial success. (Hear.) With regard to the approach that we are to make to the Brush Company, although we were told by one who, I think, should have known better—we were told by one of the directors of the Brush Corporation at our last meeting that he was authorised to say that they would have nothing to do with us. ("Quite right.") Well, perhaps, by this time Mr. Joseph Braithwaite has found out that when he speaks of his company as if he were authorized to act for it, it is not so. We have now a communication of the Brush Company before us, and we have to wait upon them next Wednesday at the invitation of the Board to consider how to make terms with them. In addition to that, I may tell you that already we have been approached by those who are anxious to take over our works at Colchester. Whether anything will come of it I cannot say, but those who are interested in electric lighting companies do not desire that this company or any other should be wiped out of existence in the way proposed. Now, that is an aspect of the question I think a very important one, that is, how will our proceedings to-day affect the interests of other electric lighting companies? And then again, how will they affect the public? I take it that all electric lighting companies at the present moment are on their trial, and whatever faith the public may have, you may depend every successive failure will weaken that faith, and therefore the chances of any other company in the future will be greatly lessened. Personally, I should be very pleased—and I have no

doubt my brother directors would be—to get rid of the trouble and anxiety attending the exercise of our duties as directors of this company. We have attended to those duties regularly for more than a year without fee or reward: we cannot therefore retire from the position in the way proposed. We take a different ground. We suggest the way we should do it; but we do not accept, and we do not believe that the required majority of the shareholders will accept, the proposal to wipe out the company in the way desired. I will leave any one of the malcontents to move the resolution.

Mr. W. Hewitt, jun., said he would not waste time by going over ground so many times traversed. The board and those who were acting with him differed very materially as to the past management, and especially with regard to the installation of the Consolidated Company. The requisitionists represented a very large number of shares; he himself held 500, and Mr. Reginald Braithwaite 1,500, so that they had a considerable stake in the company.

Mr. Lee: Mr. Braithwaite was the original broker of the company, I believe. That is a material point.

Mr. Hewitt, continuing, said Mr. Fry had remarked that they were damaging the interests of the company by their report. In the first place, he believed the board were perfectly well aware that they parted with their interests to the Brush Company some time ago; therefore, they had nothing to offer. ("No, no; quite wrong.") Well, the greater part of it, anyhow. ("No part of it.") As for Colchester, he only wanted to ask them (the directors), as gentlemen of business, could they expect any sane man to buy what was a dead loss of £1,000 a year at once? It was an ill-judged thing in the first place, going to Colchester, and he thought the board were fully aware of that now. ("No!") At any rate the shareholders were. He proposed that the company be wound up voluntarily.

Mr. Noel seconded the motion.

Mr. Offor rose to explain exactly the nature of the agreement made with the Brush Corporation, which had been termed a selling of their birthright. Under their original arrangement they had an exclusive right of selling the Brush patents in the three counties of Kent, Surrey and Essex, and they were to receive 20 per cent. discount upon anything they sold; they were also prevented by that concession from dealing with any dynamo machines or lamps except those under the Brush patents. The new arrangement was that, in the first place, the Brush Corporation increased the discount by an additional 10 per cent. upon anything they sold under the Brush patents; they then gave them the privilege of purchasing dynamos or lamps from anybody else, so that if they had a customer who preferred the dynamo machines or lamps of any other maker they were not prevented from getting a profit in that way. In exchange for these advantages they allowed the Brush Corporation to sell in their districts, subject to a commission of 10 per cent. The opinion of the board was that, so far from that being a selling of their birthright, it was an absolute advantage to this company to make the new agreement.

Mr. Lee said it was due to the directors to point out that this was a new industry, and that they had had, in conjunction with all the other companies, many difficulties to contend with. He hoped he should live long enough to see a very considerable development of electric lighting, and he thought the South Eastern Brush Company had helped to a great extent to bring this about, more particularly by the despised Colchester installation. He thought the shareholders should take that into consideration. He had no wish either way in regard to the motion before them, except to get as much of his money back as possible, if the company went into liquidation; but he was quite content to lose what he had lost or might yet lose so that he might have an opportunity of seeing a very considerable development of electric lighting. He thought some of the shareholders had been misled—he for one had been—in taking up shares in this company by the highly-respectable brokers (Messrs. Foster and Braithwaite) whose names appeared on the prospectus; and it seemed to him a little out of place for one of the principle promoters of the company to come forward in the way he had done to bring about the liquidation of the company. He (Mr. Lee) should feel called upon, not so much in his own interests perhaps as in the interests of electric lighting, to vote against the resolution.

Mr. Stewart said he was not one of those who wished to treat lightly the success of this company, because, if appointed one of the liquidators, he should do his utmost to get the outside sum possible from the parent company. He should also take steps to endeavour to sell the installation at Colchester either to the Corporation, to the gas company, or to a private company. He believed the sooner this company was wound up the better; it would not interfere with the course of electric lighting, because there would still remain the Consolidated Company. He had it from their manager, whose knowledge, he took it, was second to none in connection with these methods, that if the two companies (the South Eastern and the Provincial) were disposed of, he could do just as much business with the Consolidated Company. Besides that, they had denuded themselves of capital; they had handed over that capital to the Consolidated Company; they had only 7s. 6d. per share left to call up. Where were the means to extend this lighting? Was it not to their interest to get all they could out of the company? He was not stating anything against the directors; they came into this business in a similar manner to himself; they had all been sufferers. No doubt two years ago they were very handsomely paid; but they could not expect men of business to work unless they were paid. He hoped they (the directors) would go with them in liquidating the company, and also the Provincial Company, in which they were nearly all interested.

Mr. Lightbody said he believed the Anglo-American directors had lately made certain arrangements with some of the subsidiary companies. He wanted to ask whether any, and what, suggestions had been made by the Anglo-American Corporation in regard to taking over this company in the same way as it had taken over the businesses of the Great Western and Midland Companies. He thought it would do no harm to know this before they decided whether to wind up now or after a certain period, which would give time for such arrangements as he suggested.

The Chairman repeated that the board had received an invitation from the Anglo-American directors to meet them and consider the matter.

Mr. J. B. Braithwaite, jun., said it was quite true that an appointment had been made with his board. As he said at the last meeting that he was authorised to state, they did not see their way to making any arrangement to take over this company on the same terms as the Great Western Company; this company was in a very different position, having parted with the concessions. They would be much more ready—or fully as ready, at any rate—to treat with the liquidators, if appointed, as with the board.

Mr. Lightbody asked whether it was or was not a fact that some similar arrangement to that entered into by this company with regard to the licenses was made by the Great Western and Midland Companies.

Mr. Braithwaite said, as the late chairman of the Great Western Company and having been connected with the Midland Company, he was in a position to state that it was not a fact.

Mr. Lightbody remarked that it had been said they would lose nothing by going into liquidation. In face of the mutual arrangement existing now, as explained by Mr Offor, it was somewhat inconsistent to say they could not possibly lose anything.

Mr. Duffy asked if the parent company had the full right of supplying the districts for which this company paid a large price?

Mr. Cunningham: Subject to 10 per cent.

Mr. Duffy: Then practically we are worth nothing. We have given it back.

The motion was then put, the Chairman having stated that a majority of three-fourths would be required to carry it. The voting was—For the resolution, 11; against, 8.

The Chairman accordingly declared the resolution lost, Mr. Braithwaite thereupon claiming a poll.

Mr. Hewett then proposed the second resolution, of which notice had been given, that Mr. C. H. Stewart and Mr. Alexander Leith Riddell be appointed voluntary liquidators.

Mr. Noel seconded.

The Chairman said, before he put that resolution he wished to say two or three words, because, in the circular sent out to the shareholders by Mr. Hewitt and Mr. R. Braithwaite, the importance was mentioned of having independent shareholders to liquidate the company. He had nothing to say about the independence of Mr. Stewart; he knew he meant well in the matter. But, remembering that Mr. Riddell was a nominee of Messrs. Braithwaite, and that his holding was represented by something less than £5, he could hardly see that these were the people to be entrusted with the liquidation.

Mr. Noel: Mr. Braithwaite had an accident out hunting, and is unable to stand. Mr. Riddell's name is merely put in his place.

The motion being put to the meeting, 12 voted for and 6 against it, and the Chairman declared it lost.

A poll was ordered to be taken immediately upon both resolutions During the progress of the scrutiny,

Admiral Sir Edward Inglefield asked would the directors agree to let one of the members present who was a large holder join them as a liquidator, as a sort of guarantee to the shareholders, and that they might know what was going on at the board, and have a voice in the matter.

The Chairman said he was not authorised to speak for the board, and he would be sorry to take upon himself to answer the question at that moment; but, personally, if the company went into liquidation, he would like it left to someone outside the shareholders.

Mr. Stewart: That would lead to great expense.

Mr. Lightbody said he thought the suggestion of Admiral Inglefield a very proper one, and he thought the directors would be very pleased to have someone from among the gentlemen present to do what practically must be done on the directors' own showing.

The Chairman stated that when they met the committee of investigation they were perfectly ready to do that, and suggested that Mr. Stewart and himself should be the liquidators, but instead of seeing the board again on the subject the committee sent out the requisition for the present meeting.

Mr. Stewart said, so far as he was personally concerned, he would have been pleased to have entered into that arrangement. He thought it should be understood that the company would be liquidated, and without any further calls.

The Chairman: I make no promise. You may have driven us to it.

Mr. Hewett: Do I understand that you are pledged to the liquidation of the company?

The Chairman: You need not understand more than I told you. We shall have to go over the matter again.

Mr. Hewett: Assuming that the resolution that has been put now for the liquidation of the company by the shareholders is lost—[The Chairman: As it will be]—are you going to wind up?

The Chairman: We have said so. Of course it will come to that.

Admiral Inglefield: Is it not the case that the company will go on as if there had been no committee?

The Chairman: Certainly not. It will not go on.

Mr. Blewitt, who acted as scrutineer on the part of the movers of the resolution, now returned and said: According to my calculation we want 8,013 votes to have the required majority, and we have only 6,965. The voting is, 6,965 for the resolution, and 3,720 against.

The Chairman: The resolutions are therefore lost.

After further conversation, the meeting terminated.

## "Pilsen," "Joel," and General Electric Light Company, Limited.

NOTICE is given of a meeting to be held on the 26th inst., for the following purposes:—

1. To report the completion of the scheme for the reduction of the company's capital.

2. To submit for confirmation the appointment of Mr. George Levinge Whately as a director, with the same remuneration as the other directors appointed on the 28th August, 1884.

3. To report the progress made by the new board in realising the assets, paying off the liabilities, and reducing the expenditure, also as to the present position of the company.

The directors, in issuing the notice, submit the following statement for the information of shareholders:—

The capital of the company has now been reduced to £84,400, divided into 100 fully paid shares of £4 each, and 28,000 partly paid shares of £3 each, upon which £2 5s. per share has been called up.

The three directors appointed at the meeting of the company held on the 28th August, 1884, have nominated Mr. George Levinge Whately as a director to fill up the vacant seat at the board, and his appointment is submitted for approval of the shareholders with the same remuneration as the other three directors.

Mr. Alfred Parrish, one of the three directors, is compelled to resign his seat owing to prolonged absence from England. Mr. Fellows has continued to hold office up to the present time, but his term expires in May next. The board do not recommend that either of the vacancies be filled up.

It has not been considered necessary to incur the expense of preparing a balance sheet at the present time, but it will be satisfactory to the shareholders to learn that the whole of the company's indebtedness up to date has been discharged, and that there is a cash balance of about £1,600 in hand, besides which there are good debts due to the company on trading account amounting to about £2,000, and further assets to be realised.

The sale of the manufacturing plant and tools at the Malden Factory, by private treaty, has had the best attention of the directors, but they are of opinion that an auction sale will ultimately be necessary, and they propose to arrange for this before the 24th June, 1885, when the lease of the factory expires. The tenancy of the city offices also expires at the same date.

The company's stock of electric light plant in dynamos, lamps, &c., has been, to a considerable extent, advantageously disposed of in the ordinary course of business, the sales since 30th June last having reached about £3,900. A further amount of stock still remains, and the disposal of it in the best manner continues to occupy the board.

The staff at the factories and city offices has been reduced as far as possible, and work at the factories limited to completion of stock partly finished, repairing dynamos and lamps for customers, and maintaining existing installations.

The company are in receipt of profit rentals from installations under contract of about £1,000 a year, and have been successful in granting licences to manufacture the "Pilsen" Arc Lamp under royalties.

The directors are, in conclusion, happy to inform the shareholders that they see no prospect of any further call being necessary.

## Australasian Electric Light Power and Storage Company, Limited.

The secretary of the company writes:—"I am requested to send you the result of yesterday's poll, as shown in the certificate of the scrutineers, giving a majority for the directors of 12,136 votes, or of 11,776, if all the invalidated votes be taken into account. The directors, in announcing the result of the poll, desire me to thank the shareholders for the strong support given to them. The original directors repeat their regret that the committee, although nominated as a consultative body, formed their conclusions without conference with the directors, without affording them the opportunity of giving any explanations, and without perusing the correspondence. They willingly accept the statement of the committee that this was done in the exercise of their best judgment as to the intention of their appointment. Their report thus assumed, however, an *ex parte* character, and the directors, therefore, did not feel it incumbent on them to act upon their suggestions. The poll just taken having now disposed of the recommendations of the committee, I am desired to add that he original directors take this opportunity of carrying out their repeatedly expressed intention of dealing with the question of the fees standing in the suspense account, which have now been entirely written off, and the same principle will, of course, guide the directors in the future."

**The German Union Telegraph and Trust Company, Limited.**—The report of the directors for the twelve months ending December 31st, 1884, states that the total receipts amount to £12,460 6s. 2d., which, with a balance of £115s. 1d. brought forward from last account, makes a total of £12,462 1s. 3d. The expenses for the same period amount to £786 18s. 6d.; of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on January 20th last, and the directors recommend the payment of a further dividend of 5s. 6d. per share, making a total distribution for the year of 11s. 3d. per share, free of income tax, or at the rate of £5 12s. 6d. per cent. per annum (as against £5 17s. 6d. paid last year), leaving a balance of £155 7s. 9d. to be carried over to the next account.

**Western and Brazilian Telegraph Company, Limited.**—At the board meeting held on the 5th instant, it was resolved that in order to avoid inconvenience to the shareholders, no further conversion of ordinary shares into preferred and deferred shares shall take place until the arrears on the preferred shares be cleared off.

**The Globe Telegraph and Trust Company, Limited.**—The directors have declared an interim dividend for the quarter ending April 18th of 3s. per share on the preference shares, and 2s. per share on the ordinary shares, payable on and after the 20th proximo.

**Eastern Extension, Australasia, and China Telegraph Company, Limited.**—The first drawing for payment of the Five per cent. debentures (1880 issue), 433 in number, took place on the 18th instant, at the offices of the company, 66, Old Broad Street, E.C.

### TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th March, are £2,923, as compared with £2,770 in the corresponding period of 1884. The December receipts, estimated at £4,468, realised £4,619.

# PROCEEDINGS OF SOCIETIES.

### The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, March 12th, Mr. C. E. SPAGNOLETTI, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a paper was read by Sir DAVID SALOMONS, Bart., on "Constant Electromotive Force in an Electric Light Circuit."

It is proposed, said the author, first, to investigate a few points concerning dynamos used with accumulators for the purpose of regulating the lamps in incandescent installations, and therefrom to find some new deductions.

So far, it would appear that little attention has been given to the subject, and, in consequence, the paper has been written with the desire of helping those who may require assistance, and to propose a new starting point in the construction of dynamos.

Although a considerable proportion of the paper is theoretical, yet abundant experiments were made before coming to any conclusions, and it is hoped that the result is not entirely without a successful issue.

Let the following points be assumed:—

(*a*) That the resistance of the leads be considered as *nil*, unless mentioned otherwise.

(*b*) That in all cases we are dealing with an incandescent light installation.

(*c*) That in all cases simple shunt dynamos are used.

(*d*) That the engines and dynamos employed are of ample size.

(*e*) That the accumulator is connected up in "parallel."

Now, for an increased resistance, $r$, in any circuit, in order that the current ($= c$) shall remain unchanged, an increased E.M.F. ($= e$) must be added, and if the original E.M.F. $= E$, and the original resistance $= R$, then

$$\frac{e}{r} = \frac{E}{R} \text{ and } \frac{E}{R} = c \therefore e = c\,r.$$

Hence, the E.M.F. must always increase by a numerical value which equals the added resistance in ohms multiplied by the original current in ampères. Further,

$$r = \frac{e}{c} = c^{-1}\,e,$$

that is, if the E.M.F. vary, then, to keep $c$ constant, the added resistance must equal $c^{-1}\,e$ (numerical value) ohms.

The reasons why the lamps in any installation are not usually steady are—firstly, that the motive power is irregular, or, in other words, the E.M.F. varies; secondly, the resistance of the circuit may vary and the dynamo not be capable of giving the required E.M.F. for all values of the current taken off; thirdly, a combination of both may exist.

It is seen that if the relations $e = c\,r$ and $r = c^{-1}\,e$ can be made to exist, the light will be perfectly steady.

In practice there is no convenient way of carrying out directly these relations, but the following are five methods of keeping the E.M.F. at the lamps constant, or nearly so:—

(1) By a regular motor.

(2) By the use of accumulators working alone.

(3) By the use of accumulators placed parallel in the circuit whilst the dynamo is running.

(4) By placing in parallel any counter E.M.F.

(5) By various automatic means, magnetic and otherwise.

Method (1) can only be obtained under certain conditions which will not here be dealt with; method (2) is practically perfect; (3) is approximate, and will be the one now to be investigated; (4) is a new method, to be described; (5) will not be considered in this paper.

Installations at 100 volts are in very general use, in which cases 50 cells of an accumulator are required at a time (if E.P.S. cells are used), each cell giving about two volts, and the resistance of all the cells equal approximately one-tenth of an ohm.

In general it is found that the best charging current, not to injure the cells, is that which has an E.M.F. 10 per cent. higher than that of cells to be charged.* Hence, with an installation as above mentioned, 10 volts will be the margin, and we get

$$c = \frac{10}{0{\cdot}1} = 100 \text{ ampères.}$$

Now, in point of fact, with most known cells under such conditions about 30 ampères pass. Hence, taking the resistance of the leads,† connections, &c., altogether, and probably some internal chemical actions besides, the resistance works out about 0·3 of an ohm. Let this be so.

Let the adjustments of the installation be so made that the mean E.M.F. equal the correct working E.M.F. required for the lamps.

Then any rise or fall of E.M.F. due to the want of regularity in the motor must be neutralised, or nearly so, in order to make no perceptible difference in the light given by the lamps. One point is certain—that if, under the conditions mentioned, the E.M.F. should rise 1 per cent., the increased current sent through the cells will be 3 amperes, and so on in proportion for any other rise.

Now, in simple shunt machines whose brushes require much lead, the E.M.F. rises with a decreased flow of current in the outer circuit. Therefore a fall in the speed of the dynamo may be made to raise the E.M.F., and, on the other hand, the E.M.F. may be lowered in the case of a rise in the speed.

The important part played by the accumulator is due to the fact that its resistance is small as compared with that of the lamp circuit, and this is essential, for at those *moments* when the speed rises, and the E.M.F. rises with it, and the flow of current in consequence increases, all, or almost the whole, of this increase passes through the cells, so that no alteration takes place in the current flowing through the lamp circuit; hence the E.M.F. remains practically unaltered at the lamps for any rise of E.M.F. at the terminals of the dynamo. Therefore, if a dynamo, as described and suitably constructed, is employed, very perfect regulation is obtained by the use of cells, whether the E.M.F. rises above or falls below the normal; the cells and dynamo combined neutralising the rise of, and the dynamo making good the fall of E.M.F., since the variations in the speed are momentary.

If the increase of speed were to continue, there would be a general rise of E.M.F. throughout the circuit, that is, rapid variations would be counterbalanced, but a permanent and considerable rise in the speed would cause a slight and permanent rise of E.M.F. throughout the circuit.

From the foregoing we may conclude the following facts:—

(1) That it is necessary to use dynamos requiring a considerable lead for the brushes, so that the E.M.F. shall rise as the current flowing in the outside circuit decreases, and *vice versa*, if it is required to steady the light given by the lamps by means of accumulators.

(2) That simple shunt machines, requiring practically no lead for the brushes, and consequently an E.M.F. almost constant for all values of the current flowing in the outer circuit (especially if the magnets are nearly saturated), are not so suitable for use with accumulators for the purpose of steadying the light, although they can be used with good results for charging the cells. For example: a Siemens $SSD_{10}$ machine (for 300 lamps of 20 candle-power), whose brushes require a considerable lead; the variable current to the cells due to variations in the speed of the engine was 2 amperes (25 to 27 amperes to the cells). At the same time, the variation in the lamp circuit due to any rise or fall of E.M.F. was absolutely *nil*, being steady at 24 amperes. The experiment was then repeated under the same conditions with a Crompton 14-unit dynamo (for 250 lamps of 20 candle-power), requiring a small lead for the brushes. Result: variable current to cells 2 to 3 amperes (25 to 28 amperes); variable current in lamp circuit 1 ampere (24 to 25 amperes). Consequently this dynamo did not regulate quite so well.*

(3) That, in any particular installation, any apparatus or machine giving a counter E.M.F. equal to that of the accumulator in use, and having a like resistance, will steady the light just as well as the cells. This method the author believes to be quite new, and one capable of considerable development. For instance, a motor working parallel in the circuit, giving a constant counter E.M.F. (a motor not difficult to arrange), and having an armature of very low resistance, will effectually steady the lights with a very small expenditure of power. The chief advantage of cells is that most of the power is stored chemically, whereas in the motor-regulator it is lost—yet for many purposes the end gained is worth this loss many times over. It must also be observed that any motor, in a factory or elsewhere, with an unvarying load, and using a large current as compared with the "variable regulating current," will become a good motor-regulator, with practically no loss of power. In most cases where motors are in use in parallel with lamps, some method can always be devised for making the motor regulate at the same time.

For another method, suppose the counter E.M.F. of the motor-regulator to vary, it will evidently do so in proportion to the variations of the E.M.F. in the lamp circuit. Hence the motor might regulate the steam flowing to the steam engine, or gas going to a gas engine, in such a way as to regulate the speed of the engine; hence the E.M.F. is very like an electrical governor in its action; or the variations in the motor may vary the speed of the dynamo, leaving the speed of the engine unaltered. Or variable resistances might be inserted in the main leads, or in the F.M. shunt coils, &c.

The following is a very good way of inserting a counter E.M.F. in any installation:—Let the engine drive a dynamo (let it be called dynamo-regulator) in addition to the generator. If the speed of this dynamo-regulator is very high, and the belt driving it light, long, and slack, and its pulley made heavy to act as a fly-wheel, then this dynamo will have practically a constant speed, even when the engine is not running evenly, *i.e.*, the belt will slip over the pulley sooner than vary its speed, and the power required to drive it will be very small. To run the generator at a constant speed by this method would be too wasteful. Suppose this dynamo-regulator to be placed in "parallel," then it will give a nearly constant counter E.M.F., and this should be arranged to be nearly equal to the normal E.M.F. of the installation. It is evident that any variation in the E.M.F. above the normal, in the main circuit, will be neutralised in the same way as described in the case of the motor-regulator. Such a dynamo-regulator, employed in an installation where a gas engine is in use for the motive power, and no accumulator, would be found invaluable, rendering the light quite steady; a result almost impossible at present, when only a few lamps are on, and at best there is a slight pulsation in the light. The power absorbed by the dynamo-regulator may approximately be estimated as follows. Suppose the machine to be a "simple shunt," then the whole power required to drive it, so long as the gas engine runs evenly, is equal to the power absorbed in revolving the armature when producing the F.M. shunt current. To produce a counter E.M.F., say, of 100 volts in a 100-lamp (20-candle-power) installation would require about 0·5-I.H.P. in a suitably-constructed machine. Hence this is a constant loss all the while the engine is running. Probably this loss of power is set at too high a figure. Now, when a gas engine is working near full power it runs fairly steady, and there will be but a trivial variable regulating current passing through the dynamo armature; hence the loss of power under this condition will not be increased to any practical extent. But when the engine has only a light load on it, and its speed irregular, then the loss of power in consequence of the variable regulating current being larger, will be greater, as much possibly as 0·5-I.H.P., so that, when few lamps are in use, the extra power required to steady the light will be about 1-I.H.P. This seems very wasteful, but a great difficulty is overcome: that of getting a perfectly steady light from a gas engine when only a very few lamps are in use, and the more that are in use at a time the less the loss, till finally the loss becomes very small as compared to the total power required; yet all through the process the benefits of perfect regulation exist.

It will be observed that by all these methods both rise and fall of E.M.F. above or below the normal will be neutralised.

(4) That, if a variable resistance is employed in the shunt circuit of the dynamo, it is possible to charge the cells at any desired rate from the current given at the maximum E.M.F. the dynamo is arranged to give, down to *nil*; and this plan avoids all necessity for altering the speed, and the loss of power is very small. This method has always been employed by the writer, and has many advantages in practice. It is thus possible to work on the lamp circuit and charge at any desired rate at the same time, and in addition any desired E.M.F. may be obtained in the lamp circuit.

But the condition exists that so long as any current is entering the cells, all the current to the outer circuit is supplied

* The required difference of E.M.F. to obtain the best charging current varies with the cells employed.

† Messrs. Siemens's method of describing their conductors is the number of yards to 0·1 ohm. It is safe to pass the same number of ampères as the number of the conductor for short periods, and half its number for continuous working.

* This illustration must not be taken as expressing any opinion on the relative value of the dynamos, but only to indicate the action of each type when employed with an accumulator.

by the dynamo; and this continues until the current to the cells, by means of gradually increasing the shunt resistance, is regulated down to *nil*, when unstable equilibrium ensues, and the current to the lamp circuit is at a given moment taken half from the dynamo and half from the cells, and this relation will continue for all values of the current within the limits of the installation.* These last remarks require a slight modification in practice, for they neglect the resistance of the leads between the dynamo and the accumulator, any variation of the resistance of the cells, and any difference in the relations between the resistance of the cells and that of the armature. If all these points are taken into consideration, it will be found that the exact proportion of discharge from the dynamo and the cells, instead of being equal, will be somewhat different, but not very much so; and in the writer's installation, after experimenting with many dynamos and two sets of cells, he finds the theoretical division to be very close in practice, the leads having a very small resistance, and the dynamos being fairly suited to the accumulators. Besides other advantages gained by this method, the cells cannot be injured by overcharging or be charged too rapidly.

In short, after the point of unstable equilibrium has been reached, a dynamo and accumulator work to the line very much in the same way as two batteries, giving the same E.M.F., placed parallel, would act under similar conditions. It is also seen that, in cases where dynamos requiring much lead for the brushes are used, any decrease of resistance in the outer circuits acts in the same way as putting more resistance into the shunt circuit, and thus tends to approach the unstable equilibrium point, whereas when using those machines, requiring practically no lead for the brushes, the outer circle may be supplied almost indefinitely (within the capacity of the machine) from the dynamo, charging the accumulator at nearly the same rate all the time.

The author finds that with a "Marshall" steam engine, fitted with Hartnell's governor, the fluctuations of E.M.F. (standard 100 volts) make but an increased flow of two to three amperes to the cells when the dynamo (Siemens $SD_2$ or $SSD_{10}$) is set to charge the accumulator at the same time as supplying the lamp circuit, adjusted by means of the shunt resistance to near balancing point, and further, the nearest approach to unstable equilibrium, so as to work the lamps from the dynamo only, is that of passing three to five amperes to the cells—that is to say, if further resistance is put into the dynamo shunt circuit, at any moment unstable equilibrium ensues, due to the slight irregularity of the steam engine. Hence the rise of E.M.F. is limited to one per cent. at the terminals or the dynamo. Many experiments tend to show that in a well-arranged installation, where a gas engine is in use, the E.M.F. at the terminals of the dynamo need not vary more than ± 2 volts, and for steam engine ± 0·5 volt; these values being measured with no accumulator in circuit.

In order better to understand how the dynamo can charge the accumulator at various rates, and work to the lamp circuit at the same time, without injury to the lamps, it must be explained that one of the lamp mains must be capable of being connected (in a 100-volt installation) to the 45th cell during the time that the cells are being charged at the rate of 30 amperes, because 45 cells give 90 to 92 volts and 10 per cent. more, at the time of maximum charging, namely 99 to 101 volts. Again, if the charging is carried on at a lower rate, the lead mentioned must be switched to the 46th or some other cell till, at balancing point, the 49th or 50th is reached. Complicated as this method may appear, nothing can be simpler in practice.

It must be observed that, when charging 50 cells, and one of the lines taken off the 45th cell, the remaining five act as a counter resistance in the lamp circuit, and these have to pass the total current given by the dynamo. The evil effects of so large a current often flowing through them may be prevented in many ways, such as by creating a shunt to these cells, or having the five cells larger, so as to pass more current, or by coupling these extra cells with an equal number of the others in parallel, &c.

There is another way of looking at an installation worked with an accumulator. Let the lamp circuit be regarded, as a whole, as a variable resistance, and the accumulator as a nearly constant resistance. Then in reality the installation consists of a constant resistance with a variable shunt resistance (viz., the lamps.) This is possibly a new view of the case, and a very convenient one for solving problems.

(5) That the total capacity of any installation equals approximately the total current which may safely be taken from the cells, together with an equal current from the dynamo, if dynamos having but little lead for the brushes are excluded.

This conclusion dictates conclusively the maximum size of the dynamo, in point of economy, required in such installations.

(6) That the results here detailed may lead to many modifications in dynamos, by employing some form of counter E.M.F. regulator, instead of aiming at regulation in the machine itself, as done at present. The advantage of using this regulator will be that the machine can be made far simpler, with very few coils in the armature, and few plates in the commutator, and if massive soft iron field-magnets are employed there will be no sparking; hence a very simple machine might come into use, with good efficiency, and wound in the simplest way, capable of being used as a direct lighting machine with very good regulation, or for charging accumulators by switching on the cells in the place of the counter E.M.F. regulator.

(7) That the size of accumulator to be used in any particular installation depends on the class of dynamo used, for if its E.M.F. rises rapidly for a decreased flow of current to the outer circuit, then clearly the accumulator may be of smaller size than when the reverse is the case, so that a small accumulator will serve to regulate a large installation if the dynamo is made suitable, that is to say, what would be called a badly regulating dynamo under some circumstances would here be the best machine. Further, the accumulator must be of very large size, if to regulate at all, with dynamos requiring a very small lead for the brushes. In all cases the resistance of the cells must be small compared with that of the lamp circuit.

(8) That as a general conclusion from the above—

(i.) If dynamos requiring much lead are used, steadiness of light is secured; but it must be observed that the lamps will get a little brighter as the "run" proceeds if the current flowing to the lamp circuit remains unaltered, because the counter E.M.F. of the cells increases as the charging advances, so that the total current given by the dynamo decreases, and the E.M.F. consequently has a permanent rise.

(ii.) With dynamos having but a very small lead, the E.M.F. in the lamp circuit remains constant at all periods of the charging, except at those moments when the speed of the machine is irregular and these variations at the terminals of the dynamo are much reduced at the lamps.

(iii.) Lastly, if a dynamo as in case (i.) is employed, and a dynamo or motor-regulator is used, both defects above mentioned are overcome.

The following is a method for ascertaining what size of accumulator should be chosen for any particular installation:—

Let $E$ = resistance of cells;
" $nR$ = resistance of lamp circuit;
" $a$ = *momentary* variation of E.M.F. above the normal owing to iregularity in speed;
" $E$ = normal E.M.F.

Then, if the dynamo is a suitable one, all *momentary* fall of E.M.F. below the normal will be compensated for, and the *momentary* rise of E.M.F. is all that has to be neutralised at the lamps.

Hence, the rise of E.M.F. at the lamps will never exceed $\frac{E}{nR} \times a = \frac{a}{n}$, and the limits of E.M.F. will lie between $E$ and $E + \frac{a}{n}$.

Thus, if $a$ is large, $n$ must be large, or else $\frac{a}{n}$ has a large value, for it is required that $\frac{a}{n}$ shall be made as small as possible.

In all installations the value of $a$ can be ascertained, so that $n$ has to be found. It must then be decided as to how small a variation of E.M.F. is to be allowed at the lamps, and the latitude will depend upon what the light is to be used for; this point settled, the value to be given to $n$ is known.

To find what amount of lead a dynamo should have in any given installation,

Consider only the fall in the speed;
Let $k$ = a constant expressing the percentage of *momentary* fall in the normal speed of engine when not working regularly.

Now, the E.M.F. varies very nearly in direct proportion to the speed, when these are compared at rates not differing much from one another.

Then the varying E.M.F. below the normal may also be expressed by $k$, hence, to keep the current flowing to the cells *momentarily* constant for the decreased speed, the E.M.F. should be made to rise a percentage equal to $k$, and this can be accomplished in the construction of the dynamo.

For the lead of the brushes may vary 90°, which may be interpreted that at 0° the E.M.F. is constant for all values of the current flowing to the outer circuit, speed remaining constant, and close to 90° for a very small difference in the quantity of current taken off, an immense difference in the E.M.F. would follow. The lead can never actually be made to exist at 0° or at 90°, but at any point between. And the *lead and rise in the E.M.F.* for a decreased flow of current in the outer circuit vary directly with one another, when compared at close intervals of variation, hence the *extra lead* required to keep the E.M.F. constant at the lamps for any *momentary* fall in current flowing to the outside circuit due to irregularity in the engine is $k \times 90°$. If the usual current given by the dynamo requires a lead of $g \times 90°$, then for this machine to work with cells in any given installation the lead must be made $(g + k)\ 90°$. From this it is seen that $g$ may be made as small as desired, or variable, but $k$ depends on the character of the installation. It may be noticed that $k = a$ in the last investigation.

To obtain the required *extra lead* $k \times 90°$,
Let $n$ = polarity of the armature;
" $m$ = polarity of field-magnets;
" $p$ = angle of lead;

Then $\frac{n}{m} = \sin. p.$

In the case under consideration, $p$ being known, namely $(g + k$ 90°, the relation $\frac{n}{m}$ may be arranged as most convenient.

Returning to a 100-volt installation (50 lamps 20 candle-power

* If more resistance is inserted, then the dynamo runs as a motor, and no longer works as a generator.

with a gas engine, if we have $n = 20$ and $a = 2$, then the E.M.F. at the lamps will vary from 100 to 100·1 volts; and if a steam engine replaces the gas engine, and $n = 20$ and $a = 0·5$, then the E.M.F. will only vary from 100 to 100·025 volts. Lastly, if it is allowed to vary the E.M.F. as much, say, as one per cent., many combinations may be employed, from a very irregular motor to a very small accumulator. Also the *extra lead* will in the first case be 1·8°, and in the second one 0·045°.

It is, perhaps, diverging slightly from the subject to consider the question of starting motors by accumulators, but in many cases the dynamo is made to start the gas engine which works it in this way, so that the consideration of the question may fairly come here.

On turning the current from the accumulator to the dynamo (having an armature of appreciable resistance)* it is found that great sparking ensues, damaging the brushes and commutator, unless the current is turned on gradually through a resistance, but with machines having very low resistance armatures this precaution is unnecessary.

Why this difference? In dynamos whose armatures have a considerable resistance, the flow of current is limited in most cases to within the capacity of the cells, and there will be no appreciable fall of the E.M.F., consequently there is a strong current in the shunt coils, hence a strong field, and it is this combined with a large current flowing in the armature, which creates the mischief if no resistance is inserted at the start.

In the case of a low-resistance armature, more current is permitted to flow from the cells than they are capable of giving, hence a great fall of E.M.F. and a weak field, because very little current passes to the shunt coils. Therefore the motor starts steadily, and the power rises as the speed increases, the counter E.M.F. in consequence diminishing the current flowing through the armature gradually until the capacity of the accumulator is reached, when the ordinary laws affecting motors come into operation.

In all cases, therefore, it is advisable to start motors with a variable resistance, for in the first instance the dynamo is saved from injury, and in the second one the cells are preserved.

These remarks on motors apply to the majority of cases, since these phenomena occur only where the various apparatus are properly proportioned to one another and the installation.

Thus far have these subjects been examined, and it is hoped to carry the experiments still further, to find some new relations and facts which may prove of service to electricians.

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In the discussion which followed the reading of Sir David Salomon's paper,

The PRESIDENT said that with reference to accumulators, he would state that he had made continued experiments at the Paddington station of the Great Western Railway with Barnett's secondary cells and the results were very satisfactory; the lamps used were of the arc type and Brush pattern.

Dr. HOPKINSON said the same difficulty arose in using accumulators as in running two machines together; in the latter case a cross excitation gave good results, and he thought that something of the kind might be adopted in the case of accumulators, the latter being in circuit with the field-magnets of the dynamo.

Prof. FORBES thought that it was much to be regretted that more numerical data were not given in the paper under discussion—the statement that a slower running of the machine would give an increase in electromotive force was a novel and startling one, and he thought data ought to have been furnished to prove this. Another remarkable point was the use of a dynamo as a shunt in the main circuit. He thought the employment of a fly-wheel on the dynamo shaft (as suggested by Dr. Hopkinson) would give good results. In December, 1881, he had tried the shunt method with perfect success, but he found afterwards that he had been anticipated by Marcel Deprez. The use of a simple form of accumulator, viz., lead plates in sulphuric acid, was found to do quite as well as the shunt, the flickering of the lights being quite got rid of. If every person dealing with such questions were to give details of the currents, &c., in the various circuits a great deal of assistance would be rendered in enabling the true value of the experiments to be arrived at. Prof. Forbes then pointed out how a very low resistance accumulator between the poles of the dynamo rendered any irregular running of the latter of no effect.

Prof. ADAMS considered that accumulators were most properly used as regulators. He would point out that the use of motor regulators with alternating currents had been shown by him in the South Foreland experiments to be successful. Two dynamos and a motor gave a much steadier light than when the motor was not used, the motor, in fact, acting as a governor.

Prof. AYRTON considered the paper to be an important one, as the flickering of lamps, besides being unpleasant, probably shortened their durability. He thought that the author of the paper had not sufficiently pointed out the causes of unsteadiness. One cause was the switching off of lamps, which was not cured by the regulating method suggested. With reference to Professor Forbes's statement, he did not think the resistance of accumulators was ever so low that it could be entirely neglected in the manner stated. Prof. Ayrton then described a special form of switch for changing the number of cells in use. He also referred to an arrangement which prevented the full power of the accumulators passing through the dynamo before the latter had fairly started off.

Mr. R. E. CROMPTON did not think that Sir David Salomons' solution of the question was a perfect one. It was certainly established that in a house installation accumulators were very necessary. For such an installation simplicity was most essential. There ought to be no trouble in charging up accumulators and then leaving them, though such an arrangement was expensive. He considered the author's system too complicated for general use. Complex problems were often brought before him, such as working 110 volt accumulators with a 140 volt machine, a gas engine being the motive power. He would suggest that it would be very convenient if the connections of the field-magnets were arranged so that they could be easily coupled up either for quantity or in series. For regulating purposes nothing was so efficient as the Willan's electric governor. The use of a considerable lead on the brushes was most objectionable, as sparking would be continual without constant and careful attention. To obtain steadiness he found that a long and loose belt, which allowed a 10 per cent. slip, answered well; and as this slip only took place at the moment when the explosion in the gas engine took place, the loss of power was insignificant, the ratio being as about 130 to 132. The system of cross excitation referred to by Dr. Hopkinson had been effected by Mr. Kapp.

Dr. FLEMING stated that Edison had invented a method of regulation in which a relay introduced resistance into the field-magnets by a motor action; it was found, however, that a manual regulation of the resistance was a preferable arrangement.

Mr. WALKER described a regulator consisting of a carbon resistance, which was increased or diminished by the pressure of an electro-magnet armature; this had been used with a Brush lamp with success.

Sir DAVID SALOMONS having replied, the meeting adjourned.

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## Physical Society, March 14th.

Prof. GUTHRIE, President, in the Chair.

Capt. ABNEY read a paper upon "Recent Researches on Radiation." In general a hot body loses heat in three ways: by conduction, by convection, and by radiation. In the case of the carbon filament of an incandescent lamp the loss of heat by conduction is insignificant, and a series of experiments has been made to determine the amount of radiation, that is, the energy expended as radiant heat for every unit of electrical energy expended in the lamp. Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that at pressures between 40 millionths and one millionth of an atmosphere the radiation varies as the mean molecular free path. In the author's experiments incandescent lamps of thin glass were exhausted to different degrees, the radiation being measured by a thermopile, it was found that from 40 millionths to 10 millionths of an atmosphere the radiation increases uniformly with decrease of pressure, but that beyond this point it becomes nearly constant. A more important question is to determine the amount of radiation for any particular ray under the above conditions. This was effected by placing a small thermopile in the different parts of the spectrum. Plotting the results with watts as abscissæ and radiation as ordinates, the curves for each kind of ray are found to be very accurately hyperbolas with vertical axes. This result gives a method for rendering identical the quality of the light emitted by two lamps. We have only to find the radiation corresponding to a particular kind of light for one lamp, and then by examining the curve corresponding to that ray for the other lamp, find for what number of watts the radiation is the same.

Dr. J. A. FLEMING read a paper on "Characteristic Curves of Incandescent Lamps." The author has collected a number of statistics connecting the life, resistance, efficiency, and potential difference of incandescent lamps, and has examined them with a view of showing the mutual relations of these variations by empirical equations. A curve showing the relation of any one of them to any other is called a characteristic curve of the lamp. Among the various results arrived at was the confirmation of the law announced by Profs. Ayrton and Perry at the last meeting of the Society, that for a certain class of lamps the potential difference minus a constant varies as the cube root of the efficiency, the latter quantity being measured by candles per horse-power. The constant, which in the lamps examined is about 28·7, is nearly the potential difference at which the lamp begins to emit light, hence the law may be put into this form:—The effective potential difference varies as the cube root of the efficiency. Using the results obtained, the author then solved the problem of determining the conditions for a minimum cost per candle, and obtained a result closely agreeing with that communicated at the last meeting by Profs. Ayrton and Perry.

In answer to Lord Rayleigh, Dr. FLEMING stated that he had not calculated the increase of cost due to a variation from the most favourable conditions; it had been shown, however, by Messrs. Ayrton and Perry that the increase of cost due to a variation of potential difference amounting to three or four per cent. upon either side of the value corresponding to least cost was very small.

Mr. C. CLEMINSHAW described some "Further Experiments on Spectrum Analysis." These consisted of obtaining the inversion of the sodium line in the spectrum of the lime light. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon in which sodium is

* It is these [which generally require their brushes to have a considerable lead.

ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the inversion to the D line.

Prof. GUTHRIE, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.

An abstract of a communication by Dr. JOHN HOPKINSON on "Sir W. Thomson's Quadrant Electrometer," was read by the Secretary. According to Maxwell, the deflection produced by a given difference of potential between the quadrants is given by the formula

$$d = \lambda\,(A - B)\left(C - \frac{A + B}{2}\right)$$

where A and B are the potentials of the quadrants and C that of the needle. Dr. Hopkinson finds, however, that the constant $\lambda$ should be $\frac{\lambda}{1 + k\,C^2}$ the quantity $k$ being due to and depending on the unsymmetrical position of the needle with respect to the quadrants.

## NEW PATENTS—1885.

3004. "Construction of cables for conveying electric telegraph and telephone messages and electricity for motive power and lighting purposes." J. C. SELLARS. Dated March 7.

3005. "Laying, carrying and insulating electric telegraph and telephone wires and electric light and power wires. J. C. SELLARS. Dated March 7.

3010. "Galvanic batteries." H. J. ALLISON. (Communicated by S. Norris.) Dated March 7.

3037. "Telephonic transmitting instruments." S. P. THOMPSON, P. JOLIN. Dated March 7. (*Complete.*)

3049. "Galvanic batteries; working same." J. J. COLEMAN. Dated March 9.

3088. "Electro-deposition of copper." W. E. A. HARTMANN. Dated March 10.

3109. "Electric conductors." A. C. TICHENOR. Dated March 10. (*Complete.*)

3115. "Making carbon filaments." R. DICK. Dated March 10.

3121. "Transmitting rotary motion to dynamo-electric machines." H. LINDLEY. Dated March 10.

3212. "Dynamo-electric machines." G. HOOKHAM. Dated March 12.

3216. "Lighting railway trains by electricity." W. LOWRIE. Dated March 12.

3247. "Determining or measuring electric currents and electromotive force." O. MARCH. Dated March 12.

3257. "Apparatus for transmitting motion to, or for resisting the movement of, shafts or machinery, or for transforming force into electric force, or *vice versa*, or both." J. S. WILLIAMS. Dated March 12.

3260. "Secondary batteries or accumulators." J. PITKIN. Dated March 12.

3261. "Voltaic battery." A. KHOTINSKY. Dated March 12. (*Complete.*)

3282. "Electric arc lamp." A. P. LUNDBERG. Dated March 13.

3287. "Electrical markers for billiards and other games." T. PITTS, J. STRINGFELLOW. Dated March 13.

3298. "Measuring strength of electrical currents." G. C. FRICKER. Dated March 13.

3324. "Microphones." R. S. DEMBINSKI. Dated March 14. (*Complete.*)

3332. "Ventilating armature for dynamo-electric machines." A. L. DAVIS. Dated March 14.

3353. "Apparatus for opening electric circuits to prevent damage, applicable especially to the derived circuits in which incandescent lamps are placed." T. NORDENFELT. (Communicated by O. F. Jönsson.) Dated February 10.

3358. "Dynamo-electric generators." T. J. HANDFORD. (Communicated by F. J. Sprague.) Dated March 14.

3379. "Distributing electricity and apparatus therefor." W. P. THOMPSON. (Communicated by C. Zipernowsky and M. Déri.) Dated March 16.

3446. "Electrical generators." T. J. HANDFORD. (Communicated by F. J. Sprague.) Dated March 17.

3467. "Dynamo-electric machines." A. M. CLARK. (Communicated by L. Vissière.) Dated March 17.

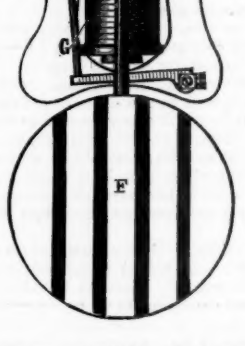
## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

1603. "Sounding at sea by electricity." W. BALCH. Dated January 17. 6d. Apparatus consists of a weight with an hollowed centre, an electric line placed in the head and secured in by an insulated plug; a line is made fast to the head of weight and secured to the electric line, a plug being attached to the bottom. Four pins are passed from the side of weight into the centre, for connecting electric wire and keeping them from the centre by a spiral spring, an India rubber band being fixed round the weight with an insulated cap, pins passing through the same. Metal levers are attached to the sides of weight for protecting springs and pins, a metal cap being attached for protecting the levers. Directly the apparatus comes into contact with the bottom or any hard substances, its own weight pressing on one of the levers causes the pin to enter the centre of the apparatus and come into contact with the points of the other pins, thus completing the circuit of electric contact and causing the alarm to be sounded on board the ship.

1789. "Improvements in dynamo-electrical machines." M. H. HURRELL. Dated January 19. 6d. The inventor makes the outer circumference of the iron core of the Gramme armature in the form of a portion of a sphere. The inner circumference is also made concentric with the outer circumference. The insulated conducting coils, which are wound transversely around the core, lie closely against the outer convex surface, and so make the outer circumference of the armature into the form of part of a sphere; whilst the part of the coils which passes across the convex interior of the core will be straight, the space so left between the coils and the core being filled in with insulating material.

2201. "An improved joint for electric conducting wires." H. J. HADDAN. (Communicated from abroad by J. Manne, of Brussels.) Dated January 26. 2d. Consists in uniting the two wires to be connected by any known joint adapted to resist the tractive efforts, allowing the ends of the wires to project over the said joint, and soldering them together (preferably after having twisted them together) in such a manner as to secure the passage of the electric current without interfering (by the heat of the soldering process) with the mechanical resistance of the joint.

3473. "Improvements in electrical self-adjusting pendulum indicators." F. KING and W. P. MENDHAM. Dated February 18. 6d. The object of the invention is to obtain a greater sensitiveness and freedom of action of the swinging pendulum in an electrical self-adjusting pendulum indicator than has hitherto been achieved, at the same time so to arrange the working parts that they may be capable of a much finer adjustment than is ordinarily accorded them. In the fig. A is a metal frame upon




which the bobbins, B, are mounted. C is a support fixed into the upper part of the metal frame and carrying needle points (shown inside the tube), D is a tube or socket resting on the tips of the needle points and carrying the pendulum, F. G is an arm proceeding from the armature pivotted below the magnet poles. Upon the passage of an electric current, the armature is attracted to the poles of the magnet and in moving strikes against the shaft of the pendulum, which at once begins swinging, and continues so to do for the space of two or three minutes, by virtue of the needle points from the tips of which it is suspended.

4208. "Improvements in the manufacture of certain parts of incandescent electric lamps." C. H. BENTON and H. H. GRUBBE. Dated March 1. 6d. The improvements consist:—First: In immersing such portion of the length of the fibres as is required

for the filaments in an acid solution, so that the outer texture is destroyed and rendered soft, in then washing the fibres and afterwards drawing them through one or more dies to reduce them uniformly to the required diameter or thickness, the fibres being subsequently submitted to the usual process of baking or carbonizing, and then receiving a deposit of carbon in the manner well known. Secondly: In forming a sound electrical joint between the carbon filament and each of its platinum supports by means of a strip of very thin foil of platinum or other suitable metal, which is formed into a cylinder or tube so as to receive the end of the filament and the platinum support. Thirdly: In forming a tight joint between the glass neck of the bulb or flask and the leading-in conductors by employing, as the leading-in conductor, a strip of foil of platinum or other suitable metal bent into an approximately tubular form or other form capable of receiving an internal piece or support of glass.

4270. "Improvements in removable key switches, applicable to fittings for electrical lamps and other purposes." G. R. WOODTURNER and W. RAWORTH. Dated March 3. 6d. The key is constructed of insulated material, knob shape, with a cased spiral spring to give additional power for a sure connection, for the electrical currant (*sic.*) with two pieces of metal, termed wards, fixed at the end of the key, for the positive and negative wires to be attached. The inventors fix two metal discs, with raised sloping flanges in an insulated material box, with a slot cut to allow the wards of the key to be inserted in the slot, to travel up the sloping raised flanges, to arrive in its properly sunk seating, the key is held secure by means of the cased spiral spring in the key. The key is seperate (*sic.*) from the box, and can be removed at will, so as not to allow persons to tamper with the lamps.

4560. "An improved system of telephonic transmission." A. M. CLARK. (Communicated from abroad by L. Maiche, of Paris.) Dated March 7. 6d. Relates to an improved system of telephonic transmission which consists essentially in the use in lieu of earth of a telegraph wire in service for telegraphic purposes without causing any interference between the concurrent action of the telephonic and telegraphic services. Fig. 1 is a diagram of the telephonic line connecting Paris and Versailles, the return wire being the telegraphic wire connecting Paris and Chartres. Fig. 2 shows details of the switch for altering the circuit according as the telephonic message is being transmitted or received, as hereafter explained. A is the transmitter, an electrophone for instance; B, is the telephone receiver; C, is the resistance above referred to; D, the telegraphic instruments, and E, the switch shown in fig. 2; and F, is the telephonic battery. When speaking the switch key, *e*, is pressed down on the contacts, $e^1$, $e^2$, under which circumstances the telephonic current acts in the ordinary way. When listening the key is not pressed down, and the contact at $e^1$, $e^2$ being broken, the current passes through the resistance, C, and the telephone, B, to the line wire. In this case the derivations due to the telegraphic service are sufficiently reduced to be inaudible, and the same is the case with the ordinary induction

FIG.1.

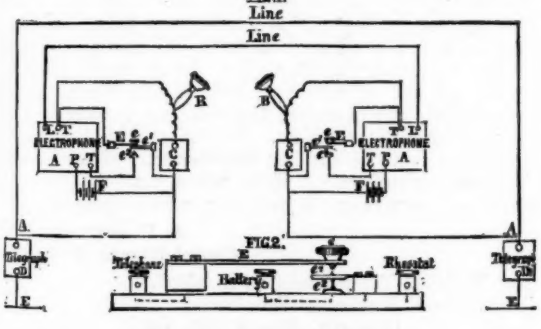



FIG.2.




which is annulled first by the action of the return wire acting as a double conductor, second by the resistance met with in traversing rheostat, C, whereby the induction currents are lost to earth by derivation by the telegraph posts. The tension of the telephonic current is so regulated as to enable it to overcome the resistance whilst reducing the derivations as much as possible, which cannot fail to be the case since the telephonic current meets with less resistance in the rheostat coil than it would meet with in order to become lost by derivation on the like. The switch, fig. 2, is so arranged that when the knob, *e*, of the spring arm, E, is pressed down its contact presses on that of the spring pallet, $e^1$, which in turn presses on the contact stud, $e^2$, and this is the position when speaking, the current then passing directly to the line. When the pressure is removed from the switch it assumes the position fig. 2, and the terminals being respectively connected as indicated in this figure it will be seen that the primary wire of the induction coil being broken the current arriving cannot act on it inductively, and therefore acts on the receiver, without causing the microphone to speak.

4874. "Improvements in electrically actuated clocks." E. G. COLTON. (Communicated from abroad by the firm of Kiek Brothers, of Amsterdam.) Dated March 14. 6d. The invention consists in a peculiar arrangement of escapement wheel and lever and spring operating the same by a pivoted armature.

5416. "An improved portable sealed galvanic battery cell, specially adapted for use in combination with an Inductorum enclosed within a dumb-bell or other exercising apparatus." H. J. ALLISON. (Communicated from abroad by J. H. Shaw, of America.) Dated March 25. 6d. Consists mainly in the combination with a bottle shaped cell, preferably made of non-conducting material, within which is enclosed and secured a cup or cylinder of carbon or other electro-negative substance, of a soft rubber stopper adapted to be forced into the contracted mouth or neck of the bottle, and from the inner end of which is suspended a zinc rod, securely connected thereto, and to a conducting wire led out through the stopper, the carbon-plate being connected with a separate conducting wire led out through the wall of the cell.

5690. "Improvements in current-regulating devices for use in the circuits of electric lamps or other apparatus." S. F. WALKER and F. G. OLLIVER. Dated March 29. 6d. The inventors place in a derived circuit between the mains an electro-magnet of high resistance, and provide the same with a pivotted armature which carries at its free end a contact piece or point of carbon or other suitable substance, arranged in combination with a similar contact piece in a fixed holder. The said armature is hinged or pivotted in a bracket to which one of the main wires is connected, the hinge or pivot being properly insulated. A fine wire connects the wire coil of the magnet with the said bracket, and a similar wire connects the said bracket with the armature lever; the latter has an end extended behind its pivot or fulcrum, and this extended end is connected by a spring with a regulating screw. Another regulating screw may be provided in any suitable position for limiting the movement of the armature. As above stated, one of the mains is connected to the bracket in which the armature lever is pivotted. The other main is connected to a stud or terminal between which and the aforesaid carbon holder we interpose a circuit of the required resistance, and preferably a variable resistance which may be an incandescent lamp of 50-candle-power or other suitable capacity. The aforesaid terminal or stud to which this resistance is connected is also connected by a fine wire with the coil of the electro-magnet, which, as will be obvious from the above description, is placed in a derived circuit between the mains. When the armature has been properly adjusted by means of the aforesaid regulating screw and spring at the extended end of the armature lever, and the engine is running at a uniform speed, and all other circumstances affecting the circuit and apparatus are in a normal condition, our improved regulator absorbs only a slight amount of current passing through the fine wire of the electro-magnet (or if the carbons are in light contact a slight additional amount of current through them) but an increase of current energy will impart to the electro-magnet sufficient force to attract the armature to it, and thereby increase the pressure of the carbon contacts, so that the increased or surplus current will pass from the first main terminal through the armature, the aforesaid contact points or pieces, and the resistance between the fixed carbon and the other main terminal.

5719. "Improvements in microphones." F. J. SEMAL. Dated March 31. 6d. Upon a suitable vibrating plate or flat piece of wood, cork, ebonite, metal, or other suitable material capable of vibrating under the shock of a wave of sound hereinafter called the "plate," are affixed two small cylinders of hard carbon, or other suitable material, disposed parallel one to the other and so as to be near each other, say, from about one-eighth to three-eighths of an inch apart more or less, according to circumstances. The two cylinders are bevelled at one end, and are by their bevelled end glued on to or otherwise attached to the plate so as to project therefrom either upwards or downwards in an inclined or slanting direction so as to form an angle with the plate; one of the said small cylinders is in communication with a telephone, whilst the other receives the current from the electric pile. The circuit is completed by a little ball of the same material as the cylinders, which ball is placed freely upon and between the cylinders, and when the said cylinders incline upwards the ball rests not only upon the said cylinders, but bears also against a point of support behind it or against the plate itself. When the said cylinders incline downwards from the plate the said ball bears against a cross piece of carbon or suitable material disposed parallel to the plate and in front of it. The mobility of the little ball under the influence of the vibratory changes produced by the shock of the waves of sound upon the plate is amply sufficient to cause variations in the intensity of the current.

## CORRESPONDENCE.

### Ball's Dynamo.

Your comparisons, in your issue of March 14th, between Ball's dynamo and those of other makers, are very interesting, but seem to me to lack some important details.

It is well known among those who have to design dynamos that an efficient machine is, as a rule, far heavier than an inefficient one of the same out-put, and it is possible to double or treble the out-put of the

modern machines by merely piling more wire on to the armature, but at the same time reducing the efficiency enormously, and increasing the sparking and other vices to a great extent.

Mr. Ball seems to me to use one field-magnet—and that by no means a heavy one—for two armatures, and he naturally has a very light machine for the out-put, but how about efficiency?

The old Grammes are wonderfully light and small for their out-put, but also wonderfully inefficient electrically. I know of an AA Gramme which runs 70 20-candle lamps easily, and weighs 495 lbs., which runs the unipolar very close.

I took some tests with it the other day, and find it to have an electrical efficiency of 65 per cent.

It would be very interesting to compare different dynamos by finding their constant, $\mu$, by the formula $\mu = \frac{V}{n\,r\,a}$ where V = volts, $n$ = number of turns on armature, $r$ = revolutions per second, $a$ = total sectional area of field-magnets.

I have found $\mu$ to be ·00061 for one of the latest and best known machines of the day, and ·00033 for an old type Gramme.

Can anyone give the necessary data and efficiency of the Unipolar and Siemens D type, which is another light machine?

**H. W. Ravenshaw.**

Halifax, *March* 16*th*, 1885.

[Our Correspondent will find full particulars of tests on the Ball machine in the ELECTRICAL REVIEW for May 17th, 1884.—EDS. ELEC. REV.].

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### Wimshurst Machines.

Your correspondent, Mr. Yatman, seems to doubt the capability of a 16 inch plate Wimshurst machine to give a 9 inch spark. It is, however, quite possible to obtain this result under favourable atmospheric conditions, provided that the machine be carefully constructed, perfectly dry, and free from dust, but it is seldom that two machines give the same efficiency, though they may be exactly alike in measurement and detail, at least so far as can be ascertained by careful inspection. I have always succeeded in obtaining 9 inch sparks from a 16 inch, and 7 inch from a 12 inch plate, under the above-mentioned conditions, by the use of a worsted thread, suspended from a wire hook which is attached to the collector, the thread hanging when at rest centrally between the knobs of the discharger. This simple contrivance has enabled me to obtain sparks several inches in length at times when the state of the atmosphere has been specially unfavourable for experimental work in statical electricity. I have found that, like a dynamo, a static induction machine has a "critical speed," beyond which the efficiency decreases proportionally to the increase in the rate of speed.

Also there is a proportion to be observed in the construction of such machines, between the area of the plates and that of the condenser, the latter being usually made too small to develop the full effect that can be obtained from the size of plate.

**Fredk. Walker.**

36, Spondon Road, Tottenham,
*March* 14*th*, 1885.

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### The Theories of Electricity.

In reply to Mr. Willoughby Smith's letter in your previous number, the experiments I referred to were first published in the *Engineer* of May 19th, 1882, page 360. In Mr. Smith's article on "Induction and Conduction," in your pages, he founded his reasoning on the following quotation from Faraday's writings:—"That non-conductors, as well as conductors, have never yet had an absolute and independent charge of one electricity communicated to them, and that such a state of matter is impossible." Now one of the foresaid experiments of mine proves the very opposite of Faraday's statement, and demonstrates that when a Leyden jar is charged internally with electricity there is not another kind of electricity in or on the outside coating of the jar; and far less is there the effect that when a Leyden jar is charged internally with what Faraday calls positive electricity, an equal quantity of what he calls negative electricity is lodged in or on the outer coating of the jar. These experiments of mine are founded on a discovery I made and published in 1839, a copy of which publication I sent to Faraday at that date. The discovery is, that a flame of coal gas, when thoroughly insulated by being burned from a small hole on the top of a glass tube, indicates the direction of a current of electricity by bending steadily in the direction of the current. All other things when placed in a current of electricity oscillate backwards and forwards, because they take on a charge of electricity; but as the gas flame cannot take on a charge of electricity it does not oscillate, but bends steadily in the one direction of the current.

**James Johnstone.**

8, Dalhousie Terrace, Edinburgh,
*March* 16*th*, 1885.

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### Storm in Aberdeen.

I notice in your issue of March 14th a paragraph which is calculated to convey the impression that the original account published by you was correct. I also notice that you incorrectly quote your own correspondent. He said "completely collapsed," you now modify it to "collapsed." I repeat that the report is ludicrously exaggerated. The serious damage was confined to one route—that mentioned in my letter of March 3rd. I can only suppose, by way of explanation, that some reporter saw the damaged route, jumped to the conclusion that every other in Aberdeen was in the same state, and communicated the supposed fact to some of the Scottish papers. From one of these your correspondent undoubtedly gleaned his information, and he has since, I presume, sent you cuttings from others by way of confirmation. Had the system "completely collapsed" it would have taken at least a year to rebuild, whereas a fortnight saw the damage nearly repaired. To-day, just three weeks after the storm, we are as we were before. As far as can be ascertained, the story of the railway porter is absolutely without foundation. In one sense the storm has proved of service—it has satisfactorily demonstrated that large numbers of light wires may fall into the streets without doing injury to person or property.

**A. R. Bennett,**
*General Manager for Scotland.*

The National Telephone Co., Limited,
8A, Royal Exchange Buildings,
Glasgow, *March* 16*th*, 1885.

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### Cox-Walker's Lamp Holder.

We have some little difficulty in answering Messrs. Faraday & Son's letter in your issue of last week, because they say they have already devised a "similar" lamp holder to the above, with jaws that "contracted" with the heat; and as the jaws of Cox-Walker's holder are made of metal, and are nipped together by metal, which would naturally "expand" by the heat, we think there is some mistake somewhere, and before replying more fully on this point, we should like a little further information.

At the same time we are very pleased to find that Messrs. Faraday & Son so far approve of Cox-Walker's holder as to say that the way in which the loops are held by them is an "undoubted advance."

**Harrison, Cox-Walker & Co.**

10, Blackwellgate, Darlington,
*March* 16*th*, 1885.

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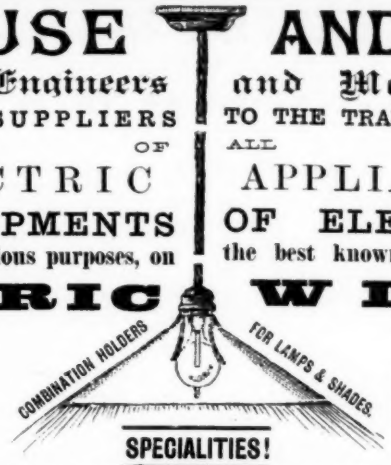


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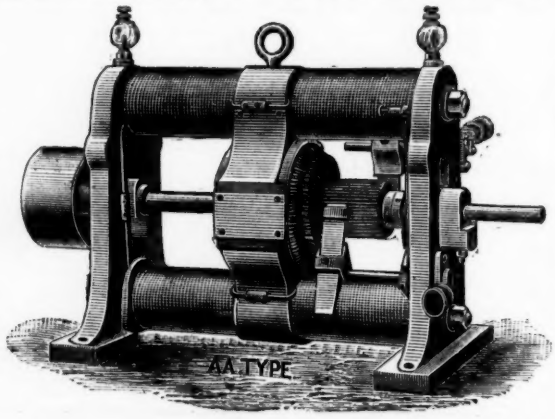


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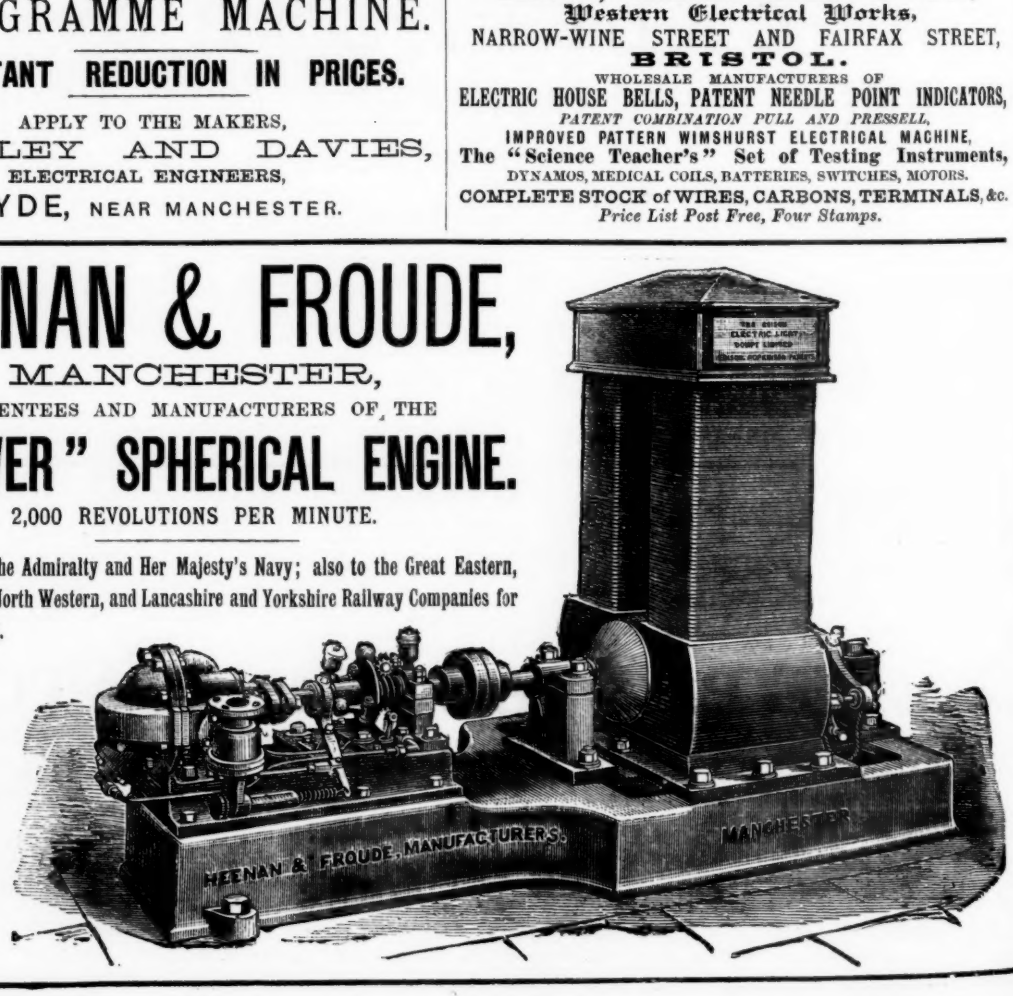
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